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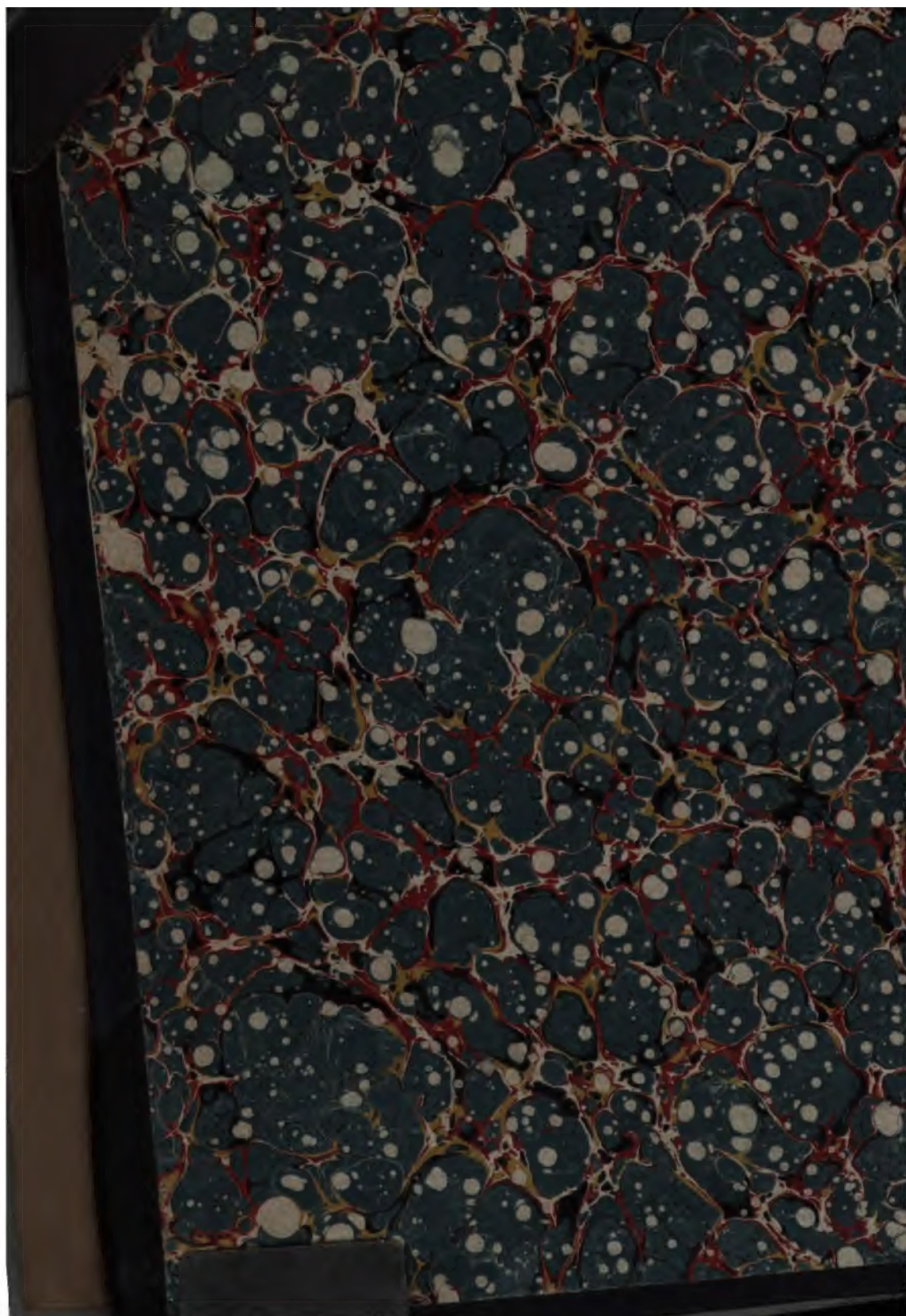
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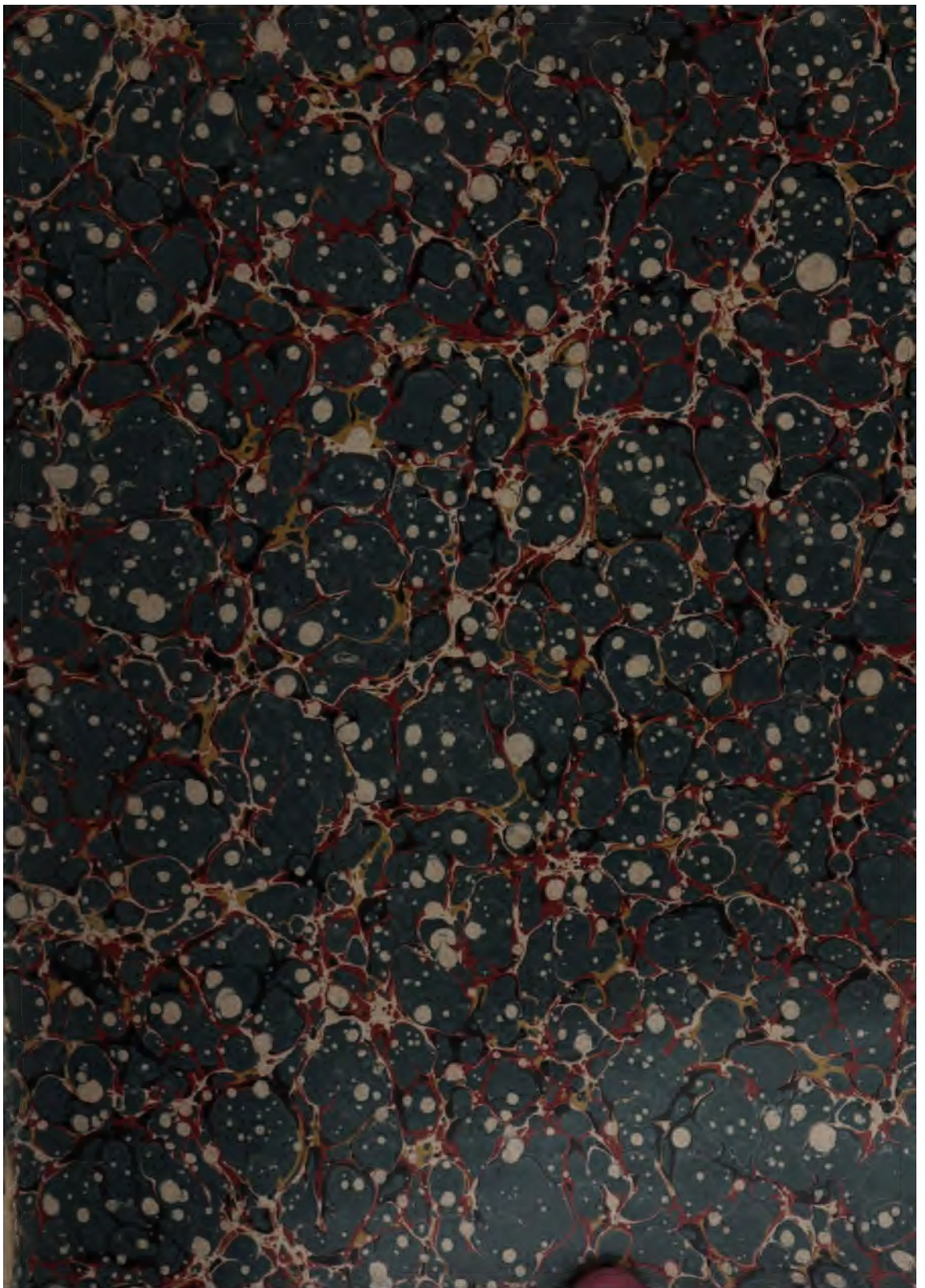
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1897-1899

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|------------------------|-----------------------|------------------------|
| No. 1, April 1, 1897;  | No. 5, Dec. 11, 1897; | No. 9, Oct. 12, 1898;  |
| No. 2, Jan. 18, 1897;  | No. 6, Jan. 18, 1898; | No. 10, Oct. 25, 1898; |
| No. 3, April 10, 1897; | No. 7, May 28, 1898;  | No. 11, Dec. 22, 1898; |
| No. 4, July 10, 1897;  | No. 8, Oct. 5, 1898;  | No. 12, May 22, 1899.  |

PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES

ZOOLOGY.                      THIRD SERIES.                      Vol. I, No. 1.

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PLASMOCYTES;


THE SURVIVAL OF THE CENTROSOMES AND ARCHOPLASM OF THE  
NUCLEATED ERYTHROCYTES, AS FREE AND INDEPENDENT  
ELEMENTS IN THE BLOOD OF BATRACHOSEPS  
ATTENUATUS ESCH.

BY  
GUSTAV EISEN, PH. D.,  
*Curator in the California Academy of Sciences.*

WITH TWO PLATES.

*Issued April 1, 1897.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1897.





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The cost of publication of the present paper has been generously contributed by two members of the Academy of Sciences, the late J. Z. DAVIS, Director of the Museum of the Academy, and W. S. KEYES, one of the Trustees of the Academy.

# PLASMOCYTES;<sup>1</sup>

THE SURVIVAL OF THE CENTROSOMES AND ARCHOPLASM OF THE NUCLEATED ERYTHROCYTES, AS FREE AND INDEPENDENT ELEMENTS IN THE BLOOD OF *BATRACHOSEPS ATTENUATUS* ESCH.

BY GUSTAV EISEN, PH. D.,  
*Curator in the California Academy of Sciences.*

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## I. INTRODUCTORY.

THE elements, or corpuscles, of the blood of *Batrachoseps attenuatus* are highly interesting, differing as they do in several important points from the corresponding elements of the blood of all other batrachians of which I have any knowledge. *Batrachoseps attenuatus* is one of the most common species of the order in this part of California, and material for study may be had at any time of the year and almost anywhere. Not only do the red cells of the blood vary enormously in size and shape, but they differ also from the blood of other batrachians in the fact that very few of them are nucleated. But the most interesting feature of the blood is the presence of a new corpuscle, which I have termed *plasmocyte*. In this paper I expect to prove that these plasmocytes are the remnants of the extra-nuclear part of fusiform corpuscles; that they consist of the archosome—archoplasm and centrosomes—which has survived, while the nucleus has been destroyed; that this archosome has surrounded itself with various envelopes

of cytoplasm; and that the plasmocytes have thus become free and independent elements of the blood. So far I have only demonstrated the presence of the plasmocytes in *Batrachoseps*, *Phrynosoma*, *Diemyctylus*, and human blood, and it is not improbable that with proper methods they will be found in the blood of other animals. This paper will, however, treat only of the blood of *Batrachoseps*; but I may be permitted to state that, as regards the human blood, the plasmocytes are so small that without first having studied the larger ones in the *Batrachoseps* blood I could never have recognized their structure. In the human blood they have been confounded with blood plates, the structure having been obscured by improper methods of investigation.

Some may, after a perusal of my plates, insist that the blood of *Batrachoseps* is so called pathological blood, on account of the abnormal form, variation in size, absence of nuclei, etc.; but I will here hasten to state that this is not the case. *Batrachoseps* possesses the same form of blood whether young or old, whether examined in the spring, in fall, or in winter. In fact, the blood described here is absolutely normal.

## II. METHODS OF INVESTIGATION.

*General Remarks.*—The delicate plasmocytes can only be studied on cover glass preparations, and even for the other corpuscles this method of investigation was found the most exact and satisfactory. Observation on moist stage and in 0.6 salt solution was also found useful and instructive. The methods generally used for preparing cover glasses with blood of higher animals are useless for batrachian blood. The large corpuscles would roll up and twist, and become so distorted that no minute details could be made out. I have obtained the best results as follows: the covers must be absolutely chemically clean and polished. For spreading the blood I use a pair of small forceps with curved prongs of exactly the same size and shape. The animal is etherized

and the head is clipped off just above the heart. Blood is then caught by the curved points of the forceps, which must be closed. The prongs are then quickly passed over the cover glass, always in the same direction and never twice over the same place, as the blood cells would then be disturbed. A zigzag movement over the glass is best when it is desirable to cover the whole surface. The forceps must not be lifted at the margin, but simply be pushed back; the quicker this is done the better the blood will be spread. The blood coagulates with great rapidity, and even if the blood supply would hold out it is hardly possible to procure more than two or three good cover glass preparations from the same animal. With some practice it is not difficult to so spread the blood that the film is only one corpuscle thick, and so that the individual corpuscles are not distorted. Great haste is necessary as a second's delay may result in failure. Furthermore, the corpuscles should be so far apart that the small plasmocytes are entirely free, as, if massed together, they cannot be properly studied.

The cover glasses are then at once placed with the film downwards on clean, dusted, blotting paper, and covered with a bell glass. This is absolutely necessary, as even under well closed bells some dust will penetrate and settle on the upper side of the glass. Afterwards these foreign substances may be mistaken for centrosomes, experience having shown me that through some cause or other these specks of dust frequently settle in just those places where a centrosome is to be expected.

After twelve hours or more of air drying, the cover glass is dropped into a shallow dish containing absolute alcohol, and allowed to remain two hours or longer. It may then be taken out and dried between blotting papers, after which it is ready for staining.

Two points are important to observe: the blotting paper must be smooth and not corrugated; and after the glass has finally become dry it must be brushed off with a fine, clean, soft brush, in order to remove all the dust, which settles with astonishing rapidity, even in a few seconds.

## III. STAINING.

I have tried a great variety of stains and found only a very few of them useful, while some, like hæmatoxylin, proved even injurious. I will mention the stains in order of usefulness as regards bringing out the details of the plasmocytes.

*Toluidine*.—Watery solution, not quite concentrated. I found this the most useful stain, since it differentiated the various spheres and zones of the plasmocyte with great precision, and without fail. The glass was made to swim in the solution for about three minutes, then washed off with distilled water and dried between pieces of blotting paper. It was then brushed off with a camel's hair brush, and mounted in gum-thus-xylol. The toluidine stains the granosphere violet, the other spheres blue, excepting the hyalosphere which remains unstained. The centrosomes stand out generally quite black. I tried a number of brands of thionin, but none gave satisfactory results as compared with the toluidine.

*Eosin-Methyl Blue "O."*—Watery solution of eosin three minutes, washing with water until the stain has receded from the blood serum, leaving only the cells stained. Then watery methyl blue "O" for about ten seconds, washing with water, and mounting as before. This method gave now and then very excellent results, as the eosin has a special affinity for the centrosphere and the hyalosphere, while it leaves the granosphere unstained, the latter being stained by the blue (fig. 49). But this method was never sure, and frequently quite unreliable, though when it succeeded it gave results not obtainable in any other way. The eosin demonstrated that the centrosphere is entirely distinct from the granosphere on one side, and from the somosphere on the other. I found methyl blue "O" more satisfactory than any other brand or variety of this stain. It stains quicker and more intensely.

*Iron-Hæmatoxylin*.—Another staining method which I have found of interest and value is the iron-alum-hæmatoxylin stain as perfected by M. Heidenhain. The method is the same

as the one used with sections; the cover glasses are first floated in one liquid, then in the other, and finally washed and mounted in the usual way. By this method the centrosomes in the plasmocytes will stain, but the cytoplasmic sphere will remain unstained. Valuable only as showing the centrosomes.

*Ehrlich-Biondi and Others.*—Useful for all elements except for plasmocytes. The latter are diffusely stained, and the respective spheres are seldom differentiated. The effect is to some degree the reverse of toluidine. The hyalosphere is never left clear and is seldom differentiated from the plasmosphere; the granosphere is frequently left lighter than the centrosphere; the other blood elements are, however, exquisitely stained. In order to attain the best results the mixture should be acidified with oxalic acid and water, and even the cover glass should finally be washed off with a weak solution of the same. In this way the centrosomal spheres in the leucocytes are brought out strongly and chromatically.

Among other stains I found metanil yellow useful in staining the plasmocytoblast while yet in the erythrocyte. It will now and then, not always, bring out the outlines sharply, but will only give a few details. The method is to first stain for several minutes with an aqueous solution of metanil yellow, wash with water, and double stain with thionin. A second staining with metanil is sometimes necessary. By this method I have demonstrated the existence of the plasmocytoblast, as well as the two outer layers of cytoplasm, in perfect, nucleated erythrocytes.

#### IV. THE BLOOD ELEMENTS.

*General Remarks.*—The respective elements in the blood of *Batrachoseps* are in short as follows: Nucleated erythrocytes, non-nucleated erythrocytes, polymorphous leucocytes, lymphocytes with solid round nucleus, fusiform corpuscles, degenerating leucocytes, and finally plasmocytes; the latter now described for the first time. Of the leucocytes there



are various kinds, the ordinary ones, eosinophile cells, and other strongly granulated cells which do not stain with any of the stains I have so far tried. While it is the fusiform elements and the plasmocytes which will principally occupy our attention, a short description of all the elements is necessary. The measurements given later have been calculated by Mr. George Otis Mitchell, whose careful measurements of the human blood cells are well known and accepted as standard.

*Non-nucleated Erythrocytes.*—These constitute by far the great majority of the red blood cells. The proportion between the non-nucleated and the nucleated red blood cells is probably as 99 to 1 at any time, though I have not made a sufficient number of countings to fully ascertain the fact. In some *Batrachoseps*, especially early in the spring of the year, the nucleated red cells are so scarce that on a well spread cover glass I have found but a single corpuscle. At other times they are much more numerous, so that in a field viewed under Zeiss *A 4* we may count from 100 to 200 nucleated red blood cells, all the others being non-nucleated. A striking characteristic of all the red blood cells, nucleated and non-nucleated, is their great variation in size. Some are smaller than the human red blood cell, while others surpass it with a diameter seven times as great in every direction; and this variation in size is not confined alone to the non-nucleated red blood cells, but also to the nucleated ones. The smallest nucleated cells besides the nucleus consist of only a very narrow rim of cytoplasm and hæmoglobin. In the non-nucleated red blood cells I have never observed any structure that I could at all identify as cytoplasm and centrosomes.

Figs. 1, 2, 3, 4, 5, and 6 represent various non-nucleated cells. There are also numerous cells of the same size and shape as those represented in figs. 7 to 11. The form of the red cells varies considerably, hardly any two being exactly alike; some are round, others oval, while many are oblong and biconcave (fig. 5).

*Nucleated Erythrocytes.*—To the description already given

I can add only a few words as regards the nucleus. The nucleus varies in size considerably, but not so much as the cytoplasmic part. The shape of the nucleus varies more than its size; thus many nuclei are round, while others are oblong. The former are represented by figs. 10 and 20, the latter by 7, 8, 9, and 11.

I have already stated that with metanil yellow and thionin part of the cytoplasm can be stained enough to show exactly the same general structure as the fusiform corpuscles, of which more further on. Of the details of the nucleus I have made no particular study, but I find that it possesses the same polarity as that described by Heidenhain. (See diagrams given in his "Kern und Protoplasma," Taf. ix, fig. 8.)

*The Fusiform Corpuscles.*—A more detailed description of these will be given further on. Here I will only state that they occur in large numbers and are more numerous than even the nucleated red blood cells. They are found in all stages of degeneration and disintegration.

*Leucocytes with Polymorphous Nucleus.*—These are found in varying numbers. In some specimens they are much more numerous than in others. In figs. 14 to 19 I have shown some types, each displaying a pronounced microcentrum which in a general way resembles those described by Heidenhain, only the microcentrum is surrounded by a small, deep-staining, starlike sphere, which sometimes separates the centrosomes and the centrospheres from each other. A somosphere I have not with certainty observed. Stained with Ehrlich-Biondi, the fine connections between the lobes of the nucleus do not become visible. These fine connections are, however, brought out with toluidine, showing that the various parts of the nucleus are in reality connected. I have never seen entirely isolated parts. These fine connections frequently show one or two minute triangular nodes of very characteristic form, but I have not given them any particular study and wish only to call attention to them. These leucocytes vary but little in size. Two of the figures, 19*b* and 19*c*, represent polymorphous leucocytes stained with

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toluidine blue. I wish especially to call attention to the starlike pink-colored zone in the center, which appears to me identical with the granosphere. It is brought out only after several hours immersion in toluidine. The centrosomes are rarely stained by the toluidine, and the archoplasmic spheres are much less distinct than when stained with Ehrlich-Biondi. This granosphere in the leucocytes is exceedingly delicate but nevertheless distinct. I have never seen any rays reach to the cell wall; they always stop in the cytoplasm. Rays are frequently seen in the leucocytes extending from the archoplasmic region toward the periphery of the cell, but they consist of two distinct substances: granospheroplasm, staining pink, and other cytoplasm, staining blue (fig. 19c). The outer part of the ray contains cytoplasmic microsomes, while the middle part of the same ray consists of microsomes of the granospheres. The Ehrlich-Biondi stain is thus misleading, as it does not differentiate the granosphere from the cytoplasm; or, if a slight differentiation is made, it appears as though the zonal rays surrounding the microcentrum are all, and throughout, of the same quality, which they are not. For the nuclei of the leucocytes the toluidine stain is entirely unsuitable, as it does not differentiate the various nuclear granulations but stains them all alike.

At times the granosphere, instead of being starlike and consisting of very minute grains of indefinable form, appears to have fallen to pieces, so to say, consisting of a smaller number of larger globular granules, irregularly scattered about, and not close enough together to form a solid sphere, or zone. The microcentrum, which is generally round in outline, is at other times starlike, irregular, or even broken up into several smaller areas, one adjoining the other as in fig. 18b, which is a toluidine stain. No distinct centrosomes are visible in the leucocyte, as indeed is generally the case with toluidine stains; but there are some shaded portions on the archoplasm which must be considered as corresponding to the somosphere, and which may or may not contain unstained centrosomes.

As regards the granulation of the cytoplasm, we can nearly always, in successful preparations, distinguish three distinct kinds besides that of the granosphere. The achromatic granule is strongly refractive and pure white, generally but not always globular, or aggregated into larger globules, around which the two other granulations are sparsely scattered as irregularly formed grains of various sizes. Some of them stain deep blue, while others have a reddish tint, fainter and more bluish than the grains of the granosphere. It appears as if the achromatic granula were of a much greater consistency than the two chromatic ones, as they assume the shape of regularly rounded granules, while the colored grains surrounding them appear compressed or stretched out, accommodating themselves to the greater consistency of the achromatic granule. This refers to the toluidine stain preparations.

*Smaller Mononuclear Leucocytes.*—These occur in varying numbers, according to the state of the blood. The nucleus is very large, round, and compact, while the cytoplasmic part is very small, being reduced to a narrow margin. Frequently this cytoplasmic part stains as if it contained hæmoglobin, and this makes me doubtful as to whether these bodies are really leucocytes. Fig. 20 represents one of them. The cytoplasm generally stains much lighter than is figured, but now and then we find a corpuscle intensely stained, as is this one.

*Leucocytes with Eosinophile Granulation.*—These are always scarce and vary greatly in size. They show cytoplasm frequently rayed as that of the true leucocytes, but the staining of the parts is reversed. The granulation stains deeply, while the rays, probably corresponding to the granosphere, remain pale as in fig. 13. The centrosomes stand out plainly, but the inner spheres do not differentiate. Figs. 19 and 20 represent two of these cells of different sizes. There are some that are yet larger, and these stain less. The smaller the cell the darker it stains.

*Leucocytes of Various Kinds in Dissolution.*—The cytoplasm and the nucleus appear to disintegrate together. In many

instances I have seen the inner spheres around the centrosomes stand out sharply, while the nucleus and other parts of the cytoplasm were in the last stages of disintegration; but I have never seen such a separation of the centrosomes and centrosomal spheres as takes place in the fusiform elements, and, judging from my observations, the microcentrum of the leucocyte does not survive. It is undoubtedly less differentiated and organized than that of the erythrocyte.

*Plasmocytes.*—I apply this name to a hitherto undescribed element in the blood, first observed by me in the blood of Batrachoseps, and later also in some other batrachians and reptiles, as well as in that of man. These new elements are much smaller than the average erythrocytes, if, indeed, an average can be struck for a corpuscle with such extreme and irregular variations as the erythrocytes in the blood of Batrachoseps. The plasmocytes are only slightly larger than the smallest erythrocytes of the Batrachoseps blood, and similarly, only a little larger than the red blood cells of the human blood; but even the plasmocytes vary considerably, and some are found which are smaller than the human red blood cells. They are generally chiefly characterized by the absence of a cell membrane, and out of about a thousand plasmocytes only six showed a rounded outline and what I considered a cell membrane. The general form is that of a round or oblong star-shaped body, with more or less frayed or amœboid projections of the outer layer, while the interior is arranged in varying concentric zones. They occur in large numbers, are more numerous than the fusiform elements, and much more numerous than the nucleated red cells. The object of this paper is to establish the identity of these plasmocytes; to trace their origin; to follow their development; and to demonstrate and prove that they are composed of the centrosomes and archoplasm (with part of the cytoplasm) of the nucleated erythrocytes, having disengaged themselves from the degenerating and dissolving parts of the fusiform corpuscles, surviving in the blood serum as free and independent elements capable of growth through assimilation of food, and taking their place as blood

elements, equal in importance to the erythrocytes and leucocytes.

#### V. THE FUSIFORM ELEMENTS.

I believe that A. B. MacCallum was the first one to determine satisfactorily that the fusiform elements, or corpuscles, in the blood of batrachians (*Necturus*) derive their origin directly from the red blood corpuscles; that they constitute, in fact, what remains of the nucleated erythrocyte after the cell wall, hæmoglobin, and possibly part of the cytoplasm, have been destroyed or separated. As regards the blood of *Batrachoseps*, this origin of the fusiform corpuscle is so apparent that few if any comments are necessary. On my slides I have frequently found nucleated cells that have been injured by pressure, or in which, for some other cause, the cytoplasmic membrane had been ruptured, thus allowing all of the hæmoglobin to escape. Such corpuscles showed the faintly staining cell membrane, with here and there tiny specks of cytoplasm around the edges; but the nucleus with surrounding cytoplasm was always stained, and in other ways exactly resembled the free fusiform corpuscles. In the yet enclosed fusiform corpuscles I frequently found the same spheres, and the same structure generally, as is seen in the free fusiform elements, with the exception that the nucleus was properly preserved, while that of the latter corpuscle was always in decay; but even in perfect and nucleated erythrocytes, stained with metanil yellow and thionin, I found now and then the cytoplasmic layers brought out in exactly the same way as in the fusiform corpuscles, which leaves no doubt as to the correctness of MacCallum's observations. A further proof is that if a drop of *Batrachoseps* blood be mixed with a drop of 0.6 salt solution and observed in a moist chamber, we will soon find that the erythrocyte loses its hæmoglobin, the cell membrane collapses, and the nucleus with adhering cytoplasm is set free. These remains of the erythrocytes closely resemble the fusiform corpuscles, or at least some of them, as it is evident that

among the latter we meet with all stages of development and dissolution; development as regards the cytoplasm, dissolution as regards the nucleus.

A fusiform corpuscle of the blood of *Batrachoseps*, if stained with toluidine, pure and simple, presents the following structure: A large central nucleus of rather irregular, oblong form, the two longer sides being always convex, while the two short sides are generally flat, or even concave, each one furnished with a dell. The nucleus itself requires little description, as it is always in a state of rapid dissolution. We find nuclei in all the various stages, some showing a distinct network with fairly well defined chromosomes, others again with only a diffuse mass of ill defined granules. In all the figures given I have, therefore, in no way endeavored to reproduce a copy of the nuclear structure, but only to show its general form and appearance, the minute details being entirely unimportant.

What attracts us the most in the fusiform corpuscle is the cytoplasmic element which adheres to the nucleus, principally at one, but frequently at both of the poles, sometimes, also, as a very thin coating on its long sides. Not only is this cytoplasmic coat thicker at the poles than on the long sides, but the structure of the polar parts is entirely different from that which adheres to the long sides. These sides are covered by a very thin layer of faintly staining cytoplasm. In some corpuscles this layer can be observed without difficulty all around the nucleus, while in others it becomes, at the middle of the long sides, so thin that it is hardly to be observed, and in some instances probably it is entirely absent. The latter appears to be the rule rather than the exception. More rarely this layer is sufficiently thick to allow us to define it in two separate layers of about equal thickness, as, for instance, seen in figs. 21 and 27; but at the poles, or at least at one of the poles, this cytoplasm is greatly increased in size, showing that it consists of a number of distinctly staining and differentiating zones or spheres. The toluidine has a marked and distinct affinity for this part of the corpuscle, and stains it in a way



that no other stain does. This differentiation is nearly always the same, and we may readily recognize each zone by the coloring alone. Thus it will be seen that while the long sides of the nucleus are covered with two of these cytoplasmic zones or spheres, the poles contain six distinct zones, the two outer being the only ones which continue all around the corpuscle. The polar accumulations must, therefore, be considered as something entirely separate from the balance of the cytoplasm; they, in fact, give rise to the plasmocytes, and may, therefore, appropriately be called plasmocytoblasts, or for the sake of brevity, plasmoblasts.

## VI. THE PLASMOCYTOBLASTS.

In a general way it may be said that plasmocytoblasts are found at each one of the poles of a fusiform corpuscle; that they stain much darker in the center or at the base, the apex and outside margin being much lighter. Thus with the toluidine stain the margin is always pale blue, while the central or basal part is more violet. At the very base or in the center are generally seen one or more dark dots which are readily identified with the centrosomes of other cells. Instead of remaining in the non-nucleated parts of the erythrocyte when the nucleus is ejected, as is supposed by Heidenhain to be the case in the erythrocyte of the rat, they continue to remain attached to the cytoplasmic envelope of the nucleus, only later on to separate from it.

As might be expected, we meet with some variation in the form, size, and staining properties of these respective zones, but in the main they are very constant and can nearly always be recognized at once. There are two differently appearing kinds of plasmocytoblasts, but between them are numerous gradations showing that the two extremes correspond, one to a stage that is dormant, the other to one that is highly active. In the former, the dark staining part with the centrosomes is situated at the base, close to the nucleus, while in the latter, the dark staining part

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appears to be in the center of the plasmocytoblast. In the former, the different cytoplasmic layers superpose each other like a series of hollow cones placed one on the top of the other on a level plane, with the centrosomes almost resting on this plane. In the other, or spherical form of plasmocytoblasts, the cytoplasmic layers surround each other as the hulls of seeds. There is here no broad base, but a number of concentric layers of different density, color, and structure. In a general way these zones correspond to the ectoplasm and to the microcentrum (somosphere with centrosomes) of some investigators, but as great confusion exists as to names I have considered it best to name each zone or sphere separately, as follows, counting from the exterior to the interior, or from the top to the base:—

A. CYTOSOME, or cytosomal spheres, ectoplasmatic spheres; spheres not part of the nucleus and archoplasm—

1. Plasmosphere.
2. Hyalosphere.
3. Granosphere.

B. ARCHOSOME, microcentrum, archoplasmic spheres, archoplasm with centrosomes; spheres not part of the nucleus or cytosome—

4. Centrosphere.
5. Somosphere.
6. Centrosome.

As will be seen, and as I expect to demonstrate in the following pages, the three outer spheres are purely cytoplasmic spheres, parts of the cell proper, for which, as a whole, I propose to retain the name cytosome, in juxtaposition to the caryosome, or nucleus, or to the three inner spheres, for which, as being of an entirely different nature, I propose the name *archosome*. This latter corresponds, at least in part, to Heidenhain's microcentrum, and to the archoplasm with centrosomes of some investigators.

The two following diagrams will illustrate this better. The first one gives the shape of the conelike plasmocyto-

blast, while the other one, which really is that of a plasmocyte, will give a fair idea of the spherical form of plasmocytoblasts.

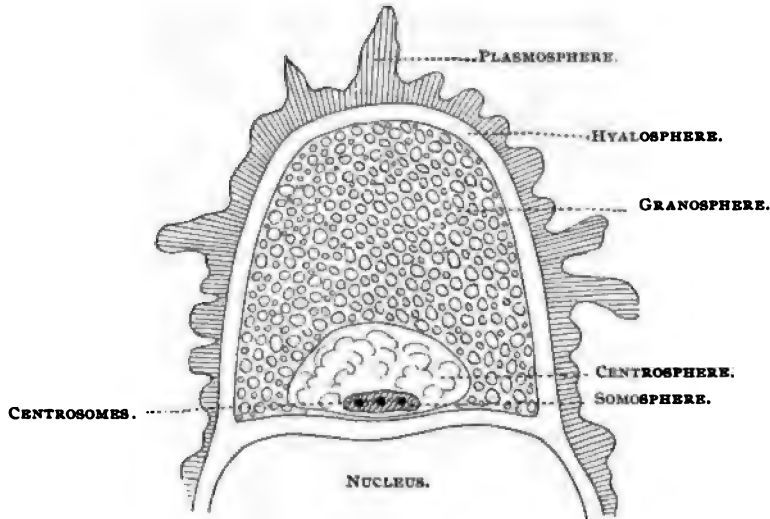


DIAGRAM 1. Plasmocytoblast at the pole of a fusiform corpuscle from the blood of a *Batrachoseps attenuatus*.

In this diagram the nucleus is represented as being below the base line, but is not further sketched out, its position only being of interest. Immediately above it is the hyalosphere, while on the sides of the nucleus extends the plasmosphere. Above the hyalosphere, at the base of the cone, is seen the somosphere containing the centrosomes; surrounding it is the centrosphere, and above it is the large dotted granosphere. The latter is surrounded by the hyalosphere and by the most exterior of all the spheres, the plasmosphere, showing fringed or amœboid projections.

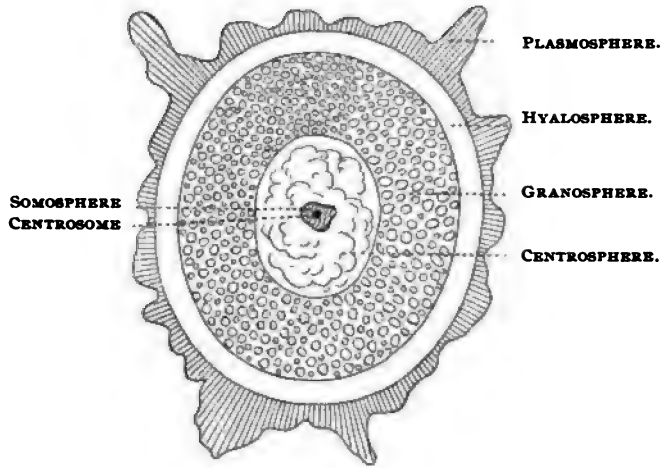


DIAGRAM 2. Plasmocyte from the blood of *Batrachoseps attenuatus*.

In this diagram the spheres have the same value as in the former, the only difference being that they have assumed a spherical form. This is a diagram of such a plasmocyto-blast as that represented by figs. 25*a*, 39, etc., while diagram 1 represents such a plasmocyto-blast as is seen in fig. 21.

Before I enter into a more minute description of the respective spheres, a few words about their general appearance may facilitate our understanding of them. In general the effect of the toluidine stain is as follows: The plasmosphere stains faintly blue, with darker blue blotches along the outer margin; the hyalosphere remains nearly always pure white, only staining faintly red with eosin, while with rubin it seldom differentiates; the centrosphere appears strongly granulated and stains deeply violet; the centrosphere stains pale blue or deep violet with toluidine, with eosin it stains deep pink; the somosphere stains generally dark, with darker centrosomes. The exceptions to this general rule will be noted further on. Fig. 21 represents a fusiform corpuscle in which the conelike plasmocyto-blast is especially prominent at the upper pole, while at the lower pole it is much smaller, and probably

wanting the microcentrum, in which case it cannot of course lay claim to the name of plasmocytoblast. In the upper one we have no difficulty in recognizing the outer plasmosphere with its fringed margin. The transparent hyalosphere comes next to it, almost or entirely unstained. The granosphere, which is very large, is stained violet, while the centrosphere is stained even deeper, rather an exception to the rule. Lowest down at the base are seen the somospheres, containing several dark spots, or centrosomes.

The other type of plasmocytoblast, represented by diagram 2, is the one that is seen in figs. 32*b*, etc. We find that the centrosphere with its enclosures has traveled away from the nucleus and the base of the cone towards its apex, much more so at *b* than at *a*. In fig. 35 we find that at the pole *b* the spheres are arranged according to the conelike type, while at the pole *a* the spheres have assumed the final spherical shape, the granosphere surrounding the archosome about equally on all sides. The variation between these two extreme types of plasmocytoblasts is such that we seldom find two which are exactly alike, still, the similarity is sufficiently great to allow us without difficulty to recognize each respective zone. We will now consider these spheres more in detail, beginning with the outer one, or plasmosphere.

## VII. CYTOSOME.

*The Plasmosphere.*—This, the most exterior sphere of cytoplasm, is especially developed at the poles, where its tendency to assume amœboid projections is very noticeable. MacCallum and Griesbach have previously described the poles of the fusiform corpuscles as being frayed. The increased size of the plasmosphere at the poles may be seen in figs. 32, 33, 34, 35, etc. The plasmosphere may be much larger at one pole of the fusiform corpuscle than at the other, and this inequality in size is also correspondingly shared by the other spheres. In other words, the spheres

increase in size together, and in such a way that the largest plasmocytoblasts are always those which inclose centrosomes and centrospheres. The plasmosphere appears fringed, partly from actually being so, partly, also, on account of a row of dots of dark-staining cytoplasm arranged along the edge. These dots never occur in a continuous line, but run in a zigzag way near the edge. The arrangement of these fringed or plasma-projections is like that of the radii in a circle or the rays of a star. The plasmosphere sometimes gives the impression of being at rest, as represented by figs. 21, 27, 34, and others. At other times it appears to have become fixed while in amœboid activity, as seen in figs. 25*a*, 29*a*, 32*b*, 33*b*, etc. While MacCallum noted the frayed appearance of the plasmosphere and figured it, his method of staining could not bring out any of the details of differentiation, though some of his figures slightly indicate that he had observed some structures corresponding to the inner spheres.

I have already pointed out that in a few plasmocytes I observed a membrane surrounding the plasmosphere, causing the corpuscle to look very much like a real cell. In the plasmocytoblast no such membrane has ever been observed, as all possess a more or less fringed plasmosphere. While in the resting stage the plasmosphere presents an outline of rounded protuberances, which may be either very small and even, as in fig. 21, or they may be large and unequal in size, as in fig. 27. When properly stained the cytoplasmic accumulation at the edges is always prominent, and we find it either in the shape of more or less regular globules, or as wedges tapering towards the hyalosphere. The toluidine is the only stain which brings out this cytoplasmic arrangement, and even a counter stain will prevent them from being observed. These small cytoplasmic masses seldom extend beyond the sharp line of the hyalosphere, and only once did I find them so irregularly scattered that the hyalosphere was obscured, as in fig. 38*b*.

The question arises as to whether the fringed appearance depends upon amœboid movements or not. As I will return

later to this subject, I will only state here that at times it certainly does. When the fusiform corpuscle is finally ejected from the erythrocyte, the cytoplasm is undoubtedly torn from the cell membrane, causing it to assume a star-like appearance, with irregular rays; but later on these rays show forms which can only be explained as the result of amœboid movements of the plasmosphere. I ascribe amœboid movements to all the spheres except the hyalosphere, which appears always dormant as far as regards change of form.

*Hyalosphere.*—This sphere extends like an even, narrow, and transparent ring all around the plasmocytoblast. On the three outer sides it is bordered by the plasmosphere, while on the side towards the nucleus it rests against this body. I believe that as a rule the hyalosphere is always found interior to the plasmosphere, though in some instances I have not been able to observe it. In fig. 27, for instance, the hyalosphere is seen below the plasmosphere all around the nucleus, and probably these two spheres always occur together. The hyalosphere appears structureless and hyaline, and is hardly stainable with toluidine. It is always highly refractive. Only by a double stain of eosin and methyl blue "O" has it been possible for me to show with certainty that the hyalosphere is a distinct sphere and not simply a thinner continuation of the plasmosphere. The eosin stains the hyalosphere pink, while the plasmosphere remains bluish. A characteristic of the hyalosphere is that it is of even size all around, like a transparent highly refractive ring, and that it shows no indication of changing its form by amœboid movements. Until the hyalosphere has closed around the forming plasmocyte, this latter, or its counterpart in the plasmocytoblast, can only be considered as a fragment of the cell, not yet having resumed that definite form which would characterize a finished or fully developed corpuscle.

*The Granosphere.*—This sphere is the most prominently noticeable of the various zones which compose the plasmocytoblasts, especially on account of its darker color, but also by its size. When small the shape is always that



of a narrow crescent, as in figs. 21*b* and 32*b*; when larger it becomes conelike, and as it recedes from the nucleus it assumes a spherical form (fig. 25*a*, etc.). As the plasmocytoblast grows and tends to separate from the nucleus, it carries with it either the whole of the granosphere, as in figs. 25*a* and 38*b*, or it leaves behind a narrow crescent of granosphere close to the nucleus, as, for instance, seen in figs. 32*b*, 39, etc. The part that moves away always contains the centrosomes or inner spheres, while the part that is left behind appears homogenous throughout, without trace of a microcentrum, except in case the microcentrum has divided, when a later emigration of a plasmocyte may take place.

While the granosphere generally stains much darker, violet dark in contrast to other spheres which stain blue, this is not always the case, and for some reason or other the staining is inverted even on the same slide. In figs. 27 and 33 the tint it has taken is deep blue and the only differentiation is in regard to the intensity of the stain. Figs. 21, 24, 29, 32, 34, and 35 contain normally stained granospheres, while figs. 27, 31, and 33 show a granosphere in which we find no trace of the red. This is to a great extent due to the time allowed the toluidine to stain. When too long the differentiation becomes less apparent, as the blue will quickly drive away the pink and violet. An immersion in the toluidine for three minutes will generally give the best differentiation, and even five minutes exposure is generally sufficient to destroy the differential effects.

The granosphere is also distinguished by its granulated protoplasm which is always quite prominent. This granulation is not even, but irregular, both as regards the size of the granules and their distribution. The periphery of the granosphere is nearly always rather even, pressing as it does against the hyalosphere. The contrast between these two spheres is sharp and striking, as in fig. 21. In size the granosphere is variable. Frequently it is very large, as in figs. 21*a*, 22, 35, etc.; at other times it is much smaller, like a thin crescent, as in fig. 23. It frequently happens

that at one pole of the fusiform corpuscle the granosphere is very large, while at the other it is small or even wanting. This I think depends upon two things: either upon the stage of development of the plasmocytoblast, or upon the absence of or defect in the centrosomes or centrosphere. Granospheres which contain no archosome do not appear to increase in size, nor do they separate from the vicinity of the nucleus and become independent. While the plasmosphere and hyalosphere often extend all around the nucleus, forming the outer lining of the fusiform corpuscle, the granosphere is always confined to the poles, as seen in figs. 21, 33, etc. Here it exerts a pressure on the nucleus, as it is this sphere which causes the dell in the nucleus, generally found at the poles. Between the granosphere and the nucleus there is always a thin rim of hyalosphere, but as this rim is even all around the nucleus it must be the granosphere which is the direct cause of the dell. Further on I will refer to this again, and then show that it is the granulated sphere which in other genera of cells also causes a similar dell. The density of protoplasm or the greater tension in the granosphere, which causes this dell, probably could not act in the absence of a cell wall, except for the apparent elasticity and strength of the hyalosphere which prevents the granosphere from escaping. The granosphere is more or less sharply defined from the inner centrosphere. The three outer spheres—plasmosphere, hyalosphere, and granosphere—undoubtedly correspond to the ectoplasm of Heidenhain, a reference to which will be made further on. While I have here referred to the granosphere as being the direct cause of the dells in the nucleus, it is probable that the indirect cause of the dells is the archosome.

The phenomena of phagocytosis will be referred to in another place. Here I will state only that they are frequently observed in the plasmocytoblasts as well as in the plasmocytes, though principally in the latter. Both of these bodies very often inclose parts of or whole red blood cells, which they are apparently in the act of digesting. Such inclosures are always found in the granosphere, from which it may be

concluded that this sphere possesses digestive properties and can be considered as the digestive organ of the cell and of the plasmocyte.

### VIII. ARCHOSOME.

*The Centrosphere.*—We will now consider a part which I think must be held analogous to the archoplasm of some investigators—the spheres surrounding the centrosomes. The centrosphere is nearly always well defined, and sometimes even separated from the granosphere by a thin but distinct unstained border. The position of this sphere in the granosphere is variable; it may be situated at the base of the cone, or it may be found in the center of the granosphere, or near one of its borders. The outline of the centrosphere is generally smooth and regular; it may be slightly uneven or cloudlike, but is nearly always very distinct, and I believe it is always present. If we consider the staining quality of this sphere we find that with toluidine it generally stains lighter than the granosphere and that it shows much less granulation. But this staining is not always constant; in fig. 35 the centrosphere at *a* is darker and star-shaped, while at *b* it is darker and conelike. In fig. 34 the centrospheres at the respective poles are stained lighter than the granosphere. This is also the case in fig. 23.

There may be from one to four centrospheres in one plasmocytoblast; when more than one is found it is evident that they constitute fragments of the original centrosphere, each fragment having assumed a more or less spherical form, and each one carrying along with it a separate granosphere, the latter also being a fragment of the original granosphere. Thus in fig. 32 we see a single centrosphere at each pole, each surrounded by an envelope of granosphere. In fig. 35*a* the centrosphere is in a state of division, while at 35*b* no activity is apparent. In fig. 36, from a fusiform corpuscle stained with Ehrlich-Biondi, we find three centrospheres at each pole, the lower pole at *b*

having spread out to such an extent as to enclose one half of the nucleus. In fig. 28 we see a plasmocytoblast with three centrospheres in different stages of development, one of which, having separated itself almost completely from the vicinity of the nucleus, and carrying with it an envelope of granosphere and centrosomes, is apparently ready to form an independent plasmocyte. In the plasmocytes the centrosphere frequently assumes a large size and becomes more differentiated, evidently a direct effect of development and growth. In fig. 49, which represents a free plasmocyte, the centrosphere is beautifully differentiated, having assumed a deep pink eosin stain. In fig. 38*a* the centrosphere is very large and rounded, pale blue, and surrounded by a narrow rim of granosphere. The centrosphere frequently assumes a star-shaped or irregular form, which indicates that it possesses independent amœboid movements.

*Somosphere and Centrosomes.*—The innermost of the spheres, which incloses one or more centrosomes, I have named *somosphere*. I have not, however, been able in every instance to demonstrate the presence of this sphere; but in many, perhaps in the majority of corpuscles observed, this sphere is distinct from the centrosomes. The dark granules, or centrosomes, accepting this name as Heidenhain understands it, are nearly always surrounded by this special sphere, which generally stains darker than the centrosphere, but sometimes also appears much lighter. It varies much in size and form, but is less regular than any of the other spheres, and undoubtedly possesses amœboid activity. In fig. 21 the somosphere is well marked, and in its center are distinctly seen the darker granules, or centrosomes. It would be incorrect to state that the centrosphere always encloses the somosphere, because frequently the latter is seen to lie at one edge of the centrosphere, as represented in fig. 34*a*; or it may be even entirely separate from it, though this may be caused by accidental pressure. If we compare figs. 22 and 23, we find that in the former the somosphere is very small, a faint tint, so to say, surrounding the granular centrosomes. In fig. 23, again, the somosphere is much larger

and lies prominently in the white centrosphere, while on the other hand it encloses two small, separated centrosomes. In fig. 38*b* the somosphere appears to be absent, the centrosomes standing out free in the centrosphere. In fig. 49, which is in many respects a very instructive one, the somosphere is stained dark blue and starlike in form, inclosing some centrosomes of rather uncertain shape. In the early plasmocytoblast the centrosomes always lie very close together, and can only with difficulty be segregated; but as the spheres grow the centrosomes separate, each carrying with it some part of one of the inner spheres. I have never found more than four centrosomes together in one plasmocytoblast, and generally their number does not exceed three. In the plasmocytoblasts the somosphere and centrosomes are too small to be readily studied, the larger plasmocytes offering much better facilities in this respect.

The relationship of the three inner spheres—those of the microcentrum—is not by far cleared up, but it seems that the somosphere and centrosomes are much more intimately connected than the centrosphere and the somosphere.

## IX. DIFFERENT KINDS OF PROTOPLASM.

The distinct differentiation possessed by the various zones naturally indicates that the protoplasm composing them consists of at least as many different kinds as there are zones. The word cytoplasm, as referable to all protoplasm contained in the cell outside of the nucleus, would thus not express and define the various kinds of protoplasm found in the inner spheres. If we, for convenience sake and with reason of a physiological difference, speak of cytoplasm as distinct from caryoplasm, we can, with equal propriety and for greater distinctness, refer to the protoplasm of the archosome as being distinct from that of the cell and the nucleus. That the spheres of the archosome must be considered as quite distinct from those of the cell and the nucleus is quite evident from what I have mentioned above, and, moreover, they must be considered as a whole

by themselves. This unity must ultimately be ascribed to difference in structure, quality, and organization of the protoplasm, entitling it to be considered separately. For the protoplasm of the microcentral spheres I therefore propose the word *archosomoplasm*, giving it equal value and importance with the cytoplasm of the cell and of the caryoplasm of the nucleus. While we may use these words for convenience sake, we may neither imply that the archosomoplasm, caryoplasm, and cytoplasm are not further separable into distinct kinds, nor that parts of cytoplasm, for instance, may not at times be found mixed with caryoplasm. How many distinct kinds of caryoplasm and archosomoplasm there really are will probably not soon be definitely decided, but I think we can safely argue that every part of protoplasm which differentiates in staining constitutes a kind of its own, differing in quality and function from the rest. That the centrosphere and somosphere do not always differentiate in the same manner does not prove that they are not always equally distinct from each other. Too long exposure to the stain will always destroy the differentiation, while at times permeation with food granules and liquids will greatly lessen or affect their susceptibility.

#### X. DEVELOPMENT OF THE PLASMOCYTOBLAST INTO PLASMOCYTES.

I have already pointed out that by arranging and comparing a series of drawings of plasmocytoblasts it soon becomes evident that they are respectively in different stages of development; not only are some of them much larger than others, but the larger ones show a differentiation not found in the others. If we study such of the figures as 28, 33*b*, 37, etc., we observe that the inner spheres have divided, a division apparently caused by a separation of the centrosomes, which latter have carried with them, each one separately, an envelope of one or two spheres. Thus in fig. 35*a* the white somosphere is dividing and in each division is found a centrosome; in fig. 33 each

somosphere has carried with it an envelope of centrosphere; while in figs. 28 and 36 each centrosphere is fully separated from the other. In fig. 28 a further stage has been reached, as here each centrosphere is surrounded by an envelope of granosphere. At a yet more advanced stage this granosphere is surrounded by an envelope of hyalosphere and plasmosphere, as seen in figs. 37, 38, and 39. The next stage consists in an entire separation of the new spherical body from the plasmocytoblast. In other words the plasmocytoblast has divided into two or more distinct bodies which have gradually freed themselves from all connection with the nucleus, or rather from the thin layers of cytoplasm yet adhering to the nucleus; the nucleus has continued to disintegrate, while new plasmocytes have steadily developed until they have become free and independent elements of the blood. That these new bodies, or blood elements, are something entirely distinct from mere fragments of the cytoplasm is evident from several observable facts. The plasmocytes increase in size, which again shows an independent growth undoubtedly caused by the taking up of nourishment; they have also moved away from the vicinity of the nucleus, showing independent movement; and finally, they have changed their form from a mere fragment to a finished, symmetrical body. The various spheres or envelopes of the new plasmocyte do not show any great irregularity, but instead exhibit a surprising regularity, especially as regards the two exterior spheres, the closing up of which forms the last step in the formation of the plasmocyte. Figs. 28*a*, 32*b*, 37, 38*a*, 38*b*, 39, etc., represent plasmocytoblasts in the last stages of development, the plasmocytes being almost perfected and ready to separate. In 37 the plasmocyte is entirely formed, while in 38*a* and 39 it is yet connected with the old fusiform element by a narrow shaft of plasmosphere.

#### XI. THE PLASMOCYTES.

*General Remarks.*—In the foregoing I have endeavored to show how the archosomes, or microcentra, of the plas-

mocytoblasts, have gradually receded from the immediate vicinity of the nucleus; how they have clothed themselves with envelopes of the outer cytoplasmic layers, or spheres; and finally, how they have entirely separated themselves from the fusiform corpuscles, henceforth existing as plasmocytes in the blood serum. These new elements possess properties which must characterize them as independent corpuscles. These properties have already been referred to as follows: Assimilation of food through phagocytosis, or through the blood serum; exhibition of independent movements which have enabled them to separate from their connection with the fusiform corpuscle and to live an independent life in the blood serum; and further, they have, from the beginning, been something else than mere fragments, each one being surrounded by ringlike spheres or zones of differentiated protoplasm, one exterior to the other, an organization which is not found in fragments.

The plasmocyte is thus characterized by the possession of form; interior and symmetrical organization; independent movement, both as a whole and as regards the separate spheres of the microcentrum; and growth by means of phagocytosis, which includes the process of digestion in the granosphere and in the somosphere.

All these properties also characterize a cell; but the plasmocytes are not cells; they lack, in fact, two most essential characteristics of a perfect cell: they possess no nucleus, and are not generally surrounded by a cell membrane.

*Homology of the Plasmocytes and the Plasmocytoblasts.*—I have carefully examined about one thousand plasmocytes, more or less, under very many stains, and find that while they vary, they do so only within certain limits, and with the exception of a dozen all told they present the same general structure. Comparing them with the plasmocytoblasts in various stages of development, we find that the plasmocyte possesses every characteristic found in the advanced plasmocytoblast, while it does not possess a single characteristic which is not also found in some plas-

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mocyto blasts, viz.: those which are ready to separate themselves from the fusiform corpuscles. Whether stained one way or the other, I find that the respective spheres behave in the same way, and that those of the plasmocyte are almost exact copies of those of the plasmocyto blast. From the youngest plasmocyto blast to the oldest plasmocyte it is not difficult to arrange a perfect series of forms showing a gradual gradation of one into another. An examination of figs. 40 to 84 will demonstrate this better.

*Different Kinds of Plasmocytes.*—While all plasmocytes possess a number of characters in common, they still differ in some degree, sufficiently to be worthy of description. For convenience sake we can segregate them into groups, according as we find in them one, two, three, or possibly four separated spheres, side by side, each containing one or more centrosomes; but between these different types there are gradations showing the variations to be of minor importance. As representative of one of these types I will refer to figs. 40, 44, 47, 49, 55, 60, etc., taken at random. The common character of these six corpuscles is that of the centrosome or centrosomes being surrounded by an envelope consisting of all the various spheres described above, concentrically arranged. In another type of plasmocyte we find that the common envelope contains only two of the spheres, the plasmosphere and the hyalosphere, while there are two or three separate archosomes, each of which has its own separate envelope of granosphere. Such plasmocytes are figured in 68, 69, 70, 71, and 72. Thus the division in the plasmocyto blast has in these not extended to the two other spheres. We have here simply an original plasmocyto blast separated from the nucleus of the fusiform corpuscle and closed up by the two outer spheres before the archosomes separated themselves sufficiently for each one to become the center of a plasmocyte. Still another type is represented by figs. 61, 63, 65, 66, 79, etc., in which we find that the division has not even extended to the granosphere. In these the granosphere is continuous in the same way as the two outer spheres, only the archo-

somes are found separated. Among these types we find those in which one centrosphere encloses one single somosphere and one centrosome, while the other centrosphere encloses two distinct centrosomes, as represented in fig. 61; or we find that one centrosphere encloses one centrosome, and that the other centrosphere contains three centrosomes as in fig. 65; or the division may be more perfect, and we find three distinct centrospheres, each one with a centrosome. In a word, a very great number of combinations may exist, each to be considered as the stage in which the plasmocyte was freed. Whether a further division of the archosome could take place in such a way that each centrosome would form the center of a plasmocyte is doubtful, and I must leave this question undecided.

*The Spheres of the Plasmocytes.*—As the spheres of the plasmocytes resemble those of the plasmocytoblast so very closely, only a few remarks will suffice to point out the more apparent characteristics.

The projections of the plasmosphere vary considerably, and I have frequently observed a striking symmetry in their position, in that they occur principally at the poles, thus giving the plasmocyte the appearance of a star, or of a starlike spindle (figs. 46, 73, 74, 51, etc.)

The hyalosphere is nearly always distinct, narrow, even, and pellucid, giving the impression of being solid, as the other spheres rarely encroach on it. It never becomes coarsely granulated, and if stained with Ehrlich-Biondi it differentiates poorly, while with eosin it sometimes stains faintly pink. I have, however, under favorable conditions observed in this sphere a very fine, regular granulation, consisting of even, rounded globules of exceedingly small size, colorless, and of great transparency.

The granosphere is, of course, the most prominent of the spheres as regards color, granulation, and size, though all of these vary within certain limits. It is this sphere which takes up foreign substances and digests them, thus exhibiting phagocytosis (fig. 79). In it we find granules of various sizes, staining more or less intensely. Sometimes the grano-

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sphere is very large, as in figs. 40, 49, 58*a*, 73, and 77; at other times it is narrow but equally distinct, as in figs. 47 and 60. The darkest granules are either accumulated at the margin near the hyalosphere or near the centrosphere, as seen in figs. 53 and 58*a*, or they are concentrically distributed as in fig. 55.

That the centrosphere is entirely distinct from the granosphere is shown by its different staining quality, by its less pronounced granulation, and by the frequently very sharp margin which separates the two spheres. Thus in fig. 49 we see the centrosphere stained pink, while the granosphere is dark blue. The above figure is from an eosin-methyl blue preparation. In fig. 58*a* the centrosphere is pale blue and the granosphere is dark blue. The somosphere is here very pale and unstained, while the centrosomes are very sharply defined. The centrosphere, more than any other sphere, exhibits amœboid movements, as seen in figs. 82, 83, etc. In order not to repeat I will leave the detailed description of the various figures to be given at the end of the paper.

The innermost enclosures of the archosome, the somosphere, and the centrosomes, may best be considered together, as they undoubtedly are very closely related and are apparently dependent on each other. Sometimes the centrosomes are not distinct, while at other times the somosphere cannot be distinguished. Again, at times, the distinction is prominent, as for instance in fig. 49, where the somosphere has assumed a deep blue, while the centrosomes of both remain dark; or, in fig. 65, where the somosphere is lighter blue; but this absence of either the centrosomes or somosphere is, I think, only apparent, being due to imperfect staining, caused by either too long or too short exposure to the stain. In all successfully stained slides the somosphere and centrosomes are never absent. I have frequently observed that the somosphere and centrosomes do not always lie in the center of the centrosphere, as in fig. 65, but at one side, as in fig. 69, or even outside of it, as in fig. 73. When there are three centrosomes pres-

ent they form a triangle (figs. 52, 58a) with a position relative to each other very much like that of the centrosomes of the lymphocytes, according to the diagrams of Heidenhain (see his "Neue Untersuchungen," figs. 3, 25, etc.), or they may simply lie in a half circle, as in figs. 52 and 65. In one plasmocyte I found four centrosomes lying in a square (fig. 60), connected by a film of somosphere. In others the arrangement was less regular and the centrosomes were placed at different depths, one above the other. At no time have I observed more than four centrosomes in the same microcentrum. The somosphere is either diffuse, spherical, crescent-shaped or ringlike. The diffuse and spherical somospheres are always homogenous or very finely granulated, while the crescent-shaped or ringlike somosphere is seen to more or less perfectly enclose one or more highly refractive yellowish bodies. When the somosphere is ringlike it is always found to be wider at one point from which it tapers in both directions towards the opposite sides. In the thickened and crescent-shaped part are found the minute centrosomes. When more than one is present they are always found close together and frequently so approximated that only the most delicate manipulation of the light will show them to be separate from each other and from the somosphere.

Between the crescent-shaped and the ringlike somosphere there are numerous intermediate links, the extreme forms being of equal frequency. These forms are undoubtedly due to the enclosures mentioned above. These are of a rather solid nature, and being always round they cause the somosphere to assume the shape of a crescent or ring; the former if the sphere is small and cannot compass the globule; the latter if it is larger and can extend all around it. That these globules constitute a food supply, perhaps derived from the granosphere, will presently be mentioned. (See figs. 81, 83, 88.) In corroboration of this is the fact that when the somosphere is crescent or ring-shaped the centrosomes appear in greater activity, actually in the process of budding (fig. 83). By budding I do not necessarily im-

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ply that new centrosomes are budded off from the mother centrosome, though this might be the case; but it may be assumed that this budding is only a part of an amœboid process, an expansion which may later on be succeeded by a corresponding contraction.

The budding of centrosomes has already been observed and described by M. Heidenhain in his "Neue Untersuchungen," and he ascribes it to a process of centrosomal division or multiplication. That such a multiplication of the centrosomes in the plasmocyte takes place is almost certain, but whether it ultimately leads to a division of the plasmocyte remains yet to be demonstrated.

The final effort of the centrosomes and somosphere is probably to separate themselves in such a way that each centrosome, with its surrounding somospheres, forms the center of an archosome and a plasmocyte; but I think that this division goes on principally while the microcentrum is yet enclosed in the plasmocytoblast. After the plasmocyte has once formed, division into two or more plasmocytes may take place, though I have only very rarely found any indication that this is the case. The impossibility of studying the plasmocyte without proper staining and fixing makes the determining of this most important question most difficult. In fixed specimens on slides I have now and then found plasmocytes which appear to be in amitotic division, but until special study has been given it this point cannot be decided.

*Food Supply in the Somosphere.*—Now and then I have observed highly refractive globules in the somosphere, which must either be parts of the somosphere, of secreted, or of foreign matter. These globules may be two or three in number, although usually there is but one. They are always dull yellowish, but strongly refractive, rounded or irregular, with sharp outlines. They are not by any means present in every plasmocyte, nor are they found on every slide, though on some slides I find them in almost every plasmocyte. Since this paper was finished in ms. I have found plasmocytes in large numbers in human

blood, and nearly every one of them possessed this same refractive globule at one side in its granosphere, seldom in the center. In the batrachian plasmocyte the somosphere lies outside on the surface of these globules, never in them.

The fact that these globules are not always present, nor consistent as regards form, size, and number, induces me to consider them as food particles which are being digested by the somosphere and which may have been either derived directly from the blood serum or secreted by the granosphere. In consistency these globules are quite dense, as may be judged from the appearance of the somosphere.

The somosphere would then stand in the same relation to the centrosome as that of the granosphere to the centrosphere and interior spheres. In other words it constitutes a digestive layer for the nourishment of the centrosomes. It is only reasonable to suppose that such delicate organisms as the centrosomes must have specially prepared nutriment, and that they are unable to directly assimilate food supplied by the blood serum and by the granosphere. The process would then be as follows: The nutriment supplied by the blood serum is digested by the granosphere; part of what results from this feeds the various spheres of the plasmocyte, especially the centrosphere; and as this nutriment is too coarse for the centrosomes, it must, in order to be assimilated by them, be further manipulated by the somosphere.

*Unequal Staining of the Archosomal Spheres.*—A point of considerable interest is the unequal susceptibility to stains exhibited by separate archosomes. For instance, in plasmocytes which contain two or more archosomes with a granosphere surrounding each, we often find that one granosphere or centrosphere has accepted a very dark stain while the other remains quite pale. Thus in fig. 65 we see that the centrosphere of the upper microcentrum is dark violet, while the lower and larger one is light blue. A similar difference is also seen in figs. 64 and 69. This unequal staining is frequently accompanied by a dif-

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ference in size. It is generally the larger sphere which stains the most intensely, and this unequal differentiation may be due either to disintegration and decay or to poor nourishment. It appears as though some of the spheres are stronger and better able to procure nourishment than others.

*General Absence of a Cell Membrane.*—That the plasmocytes are not generally surrounded by any cell membrane has already been stated. The exterior layers show projecting plasmarays entirely without any membranous covering. This might be expected on account of the origin of the plasmocyte from a part of the cell which had lost its cell membrane; but out of the very many plasmocytes investigated I have found some, not more than half a dozen in all, which, as far as concerns their exterior margin and form, present a very different appearance. These plasmocytes, if such they are, present a rounded form with smooth outline covered by a distinct cell membrane; but, unlike most plasmocytes, I could never see in them any differentiation between the plasmosphere and the hyalosphere, and even the outline of the granosphere was less well defined. I believe, however, that these bodies are real plasmocytes, though as to the cause of their structure I can venture no opinion. In fig. 59 I have represented one of them. Besides these plasmocytes I have also found in the blood very much smaller bodies, appearing like very small isolated nuclei without cytoplasm. My investigations of these are as yet unsatisfactory.

*Absence of Nucleus.*—The absence of any nuclear structure in the plasmocyte is readily explained by the well known law that the cell originates only from the cell, and the nucleus only from a previous nucleus. In one or two instances, however, I have found a structure near the center of the plasmocyte which might perhaps be called an incipient nucleus, an effort to form a new nucleus of some existing nuclear fragments which may have entered the plasmocyte. In fig. 75 such a pseudonucleus is seen, as it were, in mitosis (see also fig. 74). Such forms are, however, exceedingly rare, and these two are

really the only ones I have observed. During the disintegration of the nucleus and before the plasmocyte has separated, nuclear fragments are often seen floating about in the cytoplasmic sphere, especially in the granosphere. If any larger fragment should happen to be enclosed in the plasmocyte its influence there might be of more than momentary importance. I must, however, distinctly state that I have nowhere found anything even approaching a perfect nucleus enclosed in a plasmocyte.

*Degeneration of the Plasmocytes.*—I consider the plasmocyte shown in fig. 84 as a form resulting from degeneration. These forms are of quite frequent occurrence and of various sizes, often larger than the perfect plasmocyte. I was for a long time doubtful as to their nature and their connection with the plasmocyte, but of late I have found intermediate links which tend to prove that they are forms of plasmocytes. They are characterized by a disintegration of the plasmosphere and hyalosphere, in the place of which we only see what looks like a very delicate membrane into which radiates some substance from the granosphere. The latter is always remarkably granulated, the granules being regular and rounded, staining intensely dark. This granulation reminds me greatly of the one possessed by eosinophile cells, or by other strongly granulated forms of leucocytes. The centrosphere in these plasmocytes is always less distinct, being partly covered with the dark granules of the granosphere, but the somosphere and centrosomes stand out plainly, the somosphere generally being ring-shaped.

*Abnormal Plasmocytes.*—I have already stated that some plasmocytes show an abnormal structure which is not easy to explain. Such plasmocytes are also very rare. The variation refers generally to a duplication of certain spheres or to the presence of some sphere not found in the normal plasmocyte. Thus in fig. 47 we find on one side, the right one, a small crescent-shaped, faintly stained body pushed into the substance of the granosphere. In this instance it may be a fragment of the centrosphere. A more difficult appearance to explain is the one seen in fig. 64.

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Here we have seven or eight distinct spheres instead of six. Perhaps the simplest way to explain this is to suppose that the centrosphere, which here is pale blue, has accepted some food, or some other unusual substance which has so arranged itself that it cuts the centrosphere in two. However, this explanation is given for what it is worth, without any pretence to correctness. Every cytologist knows that now and then cells of various kinds are met with which present an abnormal structure not readily explainable. Another abnormal plasmocyte is one shown in fig. 77. Here the centrosphere appears as a broad band across the granospheroplasm. The darker margin of the band with the four black dots I consider to be somosphere and centrosomes.

As to the nature of the various black dots in fig. 56 I am undecided; they may be centrosomes or not. I think the three larger ones certainly are centrosomes, each surrounded by somosphere and centrosphere. The centrosphere of the one to the right is very large, extending across the center of the plasmocyte.

*Amœboid Movements.*—The amœboid movements of the frayed ends of the fusiform corpuscles were mentioned by MacCallum, and have probably been observed by some investigators of the large elements of batrachian blood. MacCallum, however, speaks of the slow vibratory motion of the starlike prolongations, and not of regular amœboid movements or projections, though from the general tone of his arguments (pages 245, 246) it would, I think, appear as though he considered the amœboid movements as really existing. This movement has been denied by Eberth, who holds that under ordinary circumstances such movements do not exist, at least not in the fusiform corpuscles; but I have frequently observed plasmocytes and have satisfied myself that in them such movements are common, generally very slow, but under certain conditions extremely rapid. If a drop of blood is mixed with salt solution of 0.6, we see that the plasmaprojections change rapidly, pushing out with unusual vigor to a greater

distance than under ordinary conditions, then becoming suddenly paralyzed and unable to again contract. In fig. 76 I have figured such a plasmocyte. It was at first only oblong rounded, with short plasmospheric projections. In a couple of minutes these had reached their present size.

In ordinary plasmocytoblasts and plasmocytes there is much variation in the appearance of the outer edge of the plasmospheres. In some plasmocytes the rays are pointed and very long, in others again they are rounded and scarcely projecting. While the former rays may be explained as being fragments torn from the cell membrane of the erythrocyte, the rounded appearance of the latter can only be considered as a direct effect of amœboid contraction. Another sign of amœboid movement is the presence of bacteria, foreign bodies of various kinds and size, as well as fragmentary or even whole red blood cells lodged in the granosphere of the plasmocyte. Their presence can only be explained by amœboid movements of the plasmocyte, the latter having engulfed them in the same way as do leucocytes and other wandering cells.

As regards each one of the inner spheres, separately, it is evident that the peculiar forms frequently possessed by them must be attributed to amœboid movements. Such undoubted activity is especially seen in the centrosphere, and to a lesser extent in the granosphere and somosphere. In each one of these spheres we can recognize a resting stage and a stage of amœboid activity. While the resting form of each of these spheres must be considered as approaching a disk, other forms frequently occur which cannot be the effect of accidental pressure or disturbance. As a plasmocyte with a resting archosome, I consider, for instance, the one shown in fig. 47, where both the centrosphere and the somosphere are oval. Figs. 27, 48, 49, 68, 69, 82, and others, show the various spheres of the microcentrum as arrested in the amœboid stage. That this amœboid stage is not confined to the plasmocyte as a whole is evident from such figures as 23, 32*b*, 35*a* and 82, all of which show signs of a most active movement of the

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centrosphere. In fact the whole progressive movement of the archosome, from the base of the bud (plasmocytoblast) to its center or upper part, must be ascribed to such amœboid movements as those indicated in the figures. Similar forms indicating amœboid movements of the microcentrum have been described by Rawitz in his paper, "Untersuchungen über Zelltheilung," and are illustrated principally in figs. 2 and 3 of said paper. In these and other figures in that paper we also find the granosphere clearly delineated and described as "Zellsubstanzhof."

*Growth and Phagocytosis.*—While a large number of plasmocytes are not any larger than the largest divisions of the plasmocytoblasts, many of them are much larger than any that I have seen while yet enclosed in the plasmocytoblast. From this I infer that the plasmocytes increase in size—that they actually grow. Between the smallest plasmocytes and the largest ones there are those which are of all intermediate sizes. I have measured plasmocytes which were as large as the nucleus of the fusiform corpuscle, but the majority are much smaller, as will be seen by the measurements given further on. This growth can hardly be caused by anything but an assimilation of food. The food supply is probably mostly derived from the blood serum, but some of it, at least, is at times attained by a direct process of phagocytosis. Thus I have frequently encountered plasmocytes which had engulfed small erythrocytes or their fragments, some of the latter appearing to be in a state of decomposition. On every cover glass such examples of phagocytosis are often found. In fig. 79 I have represented a phagocyte which has swallowed a very small erythrocyte, the more interesting because this erythrocyte contains a parasitic protozoa, the life history of which I will soon describe. In many instances, however, what appears to be phagocytosis is not really so. We frequently find that a plasmocyte overlaps, or is superposed, on a red corpuscle, in which case it at first appears as if the plasmocyte was in the act of digesting the red cell. All around the outlines of the plasmocyte there is seen a pale margin, as if

the hæmoglobin in the red cell had been consumed by the plasmocyte. But this is mere illusion, because the pale ring or area is caused by the pressure of the overlying plasmocyte which has pushed the hæmoglobin away from its immediate vicinity. Again, wherever phagocytosis occurs no such displacement of the hæmoglobin takes place, as illustrated by fig. 79. Even in the plasmocytoblasts such phagocytosis is frequent. I have already mentioned that the enclosures are principally found in the granosphere, which is thus to be considered as the seat of digestive activity in the cell.

*Duplicity of the Plasmocytoblasts.*—A very noticeable fact is the frequent occurrence of a plasmocytoblast at each of the opposite poles of the fusiform corpuscle, or rather, more strictly speaking, of the degenerating nucleus. In some instances, even when the granosphere is distinct at each pole, I have not been able to discover the inner spheres and centrosomes; but in the majority of fusiform corpuscles the respective cytoplasmic spheres, with an archosome, are found at each pole. It appears at the beginning of the degeneration and disintegration of the nucleus, or at the moment when the cell membrane was ruptured and the hæmoglobin was diffused, that the erythrocyte was not in actual rest, but at the beginning of mitosis. The centrosomes and archoplasm had evidently already separated and moved to opposite poles of the nucleus, where at their resting places they had caused a dell to appear. The destruction of the cell and its transformation into a fusiform corpuscle, is, therefore, not likely to have been caused by any defect in the centrosomal spheres or archosome, but rather from some defect in the nucleus itself. This defect, whatever it may have been, prevented the chromosomes from passing through the preliminary stage of mitosis; they were therefore unable to respond to the action of the archosome. The nucleus in which, at this stage, we should expect to find a great activity among the chromosomes had thus died, that is to say it had become disorganized or paralyzed, so that the action of the centrosomes, instead of

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exerting itself on the nucleus, caused the cell wall to rupture and the fusiform corpuscle to be set free in the serum. The very fact that the centrosome and plasmospheres survive—nay, grow, develop, and continue an independent life—while the nucleus perishes, points to this conclusion. The nucleus of the fusiform corpuscle is, as compared to the nucleus of the erythrocyte, always in a state of degeneration. The various kinds of chromosomes are neither distinguishable in shape nor color, and consist of a mere irregular mass of globules of various sizes, more or less concentrated towards the center. There is an entire absence of those fine and exquisite details found in every perfect nucleus. The nuclear membrane—the caryotheca—is also frequently ruptured, and we can see small parts of the nuclear plasma diffusing in an irregular way through the cytoplasm, indicating dissolution and decay.

Dr. A. Dehler, who was the first to demonstrate the microcentrum in the erythrocytes of the chicken embryo, describes and figures only one set of centrosomes in the resting blood cell. Also M. Heidenhain, who has so studied in detail the nature of the leucocyte, refers only lightly to the microcentrum of the erythroblast. In figs. 15 and 16 (“*Neue Untersuchungen*”) he figures two nucleated red blood cells with centrosomes partly visible in the cytoplasm. Fig. 16 interests us most because the nucleus with the polar projections bears a strong resemblance to the fusiform elements of *Batrachoseps* blood. Heidenhain does not enter upon any detailed description of these cells but simply states that according to his conclusions the ejection of the nucleus is caused by the tension of the aster rays, in conformity with his now well known tension theory. He believes, also, that after the ejection of the nucleus the centrosomes remain in the erythrocyte. Whatever may be the case with the erythrocytes of the rabbit, I am positive, as regards the fusiform elements of the *Batrachoseps* blood, that the centrosomes remain in the plasmocytoblast.

*The Ultimate Fate of the Plasmocyte.*—A remarkably small proportion of plasmocytes show signs of dissolution,

probably not ten per cent., and these appear to be full of large and small vacuoles. The spheres become less distinct, finally diffusing one into the other, and no longer responding to the stains. They become more transparent as the plasma evidently becomes less dense. The interior spheres are the first to disappear from view, the centrosomes with them. In the last stages of its existence the plasmocyte resembles a large diffuse blood plate. Fig. 78 represents a dissolving plasmocyte with both large and small vacuoles stained with Ehrlich-Biondi. Judging from the few which thus decay, I conclude that the life of a plasmocyte is fully as long as that of a nucleated blood cell, and probably much longer.

*Adhesive Nature of the Cytoplasm.*—Every one who has observed the fusiform corpuscles has remarked upon the adhesive nature of the outer cytoplasmic layer. Frequently a number of such corpuscles are seen adhering together, forming irregular discs. The plasmocytes act exactly in the same way. Not only are they found joined or attached to each other but frequently they are also seen adhering to the margin of the plasmocytoblasts. It is not always easy to determine when we have before us a free plasmocyte whether it is simply adhering to the cytoplasm of a plasmocytoblast or is separating from it. The continuation of the two outer spheres must be the criterion of this, though in the first stage of the plasmocyte the difference cannot be very great. If there is any large amount of granosphere yet in position at the apex of the nucleus, and if this granosphere is conelike and contains a microcentrum, we may assume, with great probability, that the adhering plasmocyte is really only adhering and not in the act of separating. After all the plasmocytes have separated from the plasmocytoblast there often remains a thin crescent of granosphere close to the nucleus, but this crescent does not contain any parts of an archosome, therefore cannot produce other plasmocytes.

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## XII. THE INDEPENDENCE OF THE ARCHOSOME.

From the foregoing observations it will be seen, at least in the fusiform elements of the blood, that the archosome shows an independent life history—surviving, growing, and changing long after the other constituents of the cell have disintegrated. As far as I can see the plasmocyte occupies a position equal to that of a real cell. It has all the general qualities of the cell as understood by modern cytologists, with perhaps one exception—the power to reproduce itself; at least no instance of unqualified plasmocytic division has come under my observation. The question now arises as to the relationship which the archosome bears to the nucleus and the balance of the cell. As is well known, there are two opposite views on this matter: one which considers the centrosome a constituent of the cell, always present and of paramount importance in directing the mitosis; the other claiming that the centrosome is only an organ in the cell (like the heart in the animal body), either always present or temporarily differentiated at the time of mitosis—a larger microsome, whatever that may mean, but nothing more. According to the latter theory the only function of the centrosome would be to mechanically direct and carry out the complicated stages of the mitosis, and when this was accomplished its work would be ended. This theory sufficed as long as centrosomes were not found in cells which had lost the power of division, or which would never again divide by caryokinesis; but we now know that centrosomes and archoplasm occur in cells in which cell division will never be repeated. It is not my intention to enter upon this subject extensively at present. However, I will here point out that if we concede that the microcentrum, or archosome, is always present in every cell, and can recognize that the archosomes in some cells, as for instance in the fusiform corpuscles of *Batrachoseps*, survive all other parts; that they clothe themselves with various envelopes of cytoplasmic spheres; that they increase in size and assimilate food; that they remain entirely independent of former asso-

ciates in the cell; and that they are always minutely organized in the same manner;—then, I think, we cannot help but conclude that the centrosome is something other than a larger microsome situated at the junction of the rays of the attraction spheres, in which these rays are inserted, and whose temporary function is to direct the chromosomes and in other ways accomplish caryokinesis.

*I hold, therefore, that the archosome, with its spheres and centrosomes, is not a temporary organ of the cell, but is a most important vital center, capable, under favorable conditions and when clothed with certain cytoplasmic envelopes, of growth, assimilation of food, and of movement—in fact, existing as an independent element of the blood.*

Connected with this question is another of no less interest—the theory of symbiosis, of which Watasé is now a well known champion. Is the nucleus an organ in the cell, or is it an independent organism—a messmate, so to say—which has associated itself with the balance of the cell for mutual benefit—in symbiosis? Watasé has done full justice to this theory which in many respects is a most plausible one, and is according to my views most probable. I can do no better than to refer to his admirable lecture upon this subject. But strange to say, Watasé, who has so ardently advocated a symbiosis of the nucleus with the cell, has also as eagerly endeavored to destroy the very foundation upon which this theory must rest. Referring to his paper upon the independence of the centrosome, we find that he has used every argument to show that the centrosome is merely a large microsome, a variable organ in the cell. Now it can be shown, as I believe I have demonstrated, that the centrosome, with the archoplasmic spheres, is something much more than an organ in the cell, that it constitutes in reality the most vital part in the cell, the surviving center of energy after the connection with the nucleus has been dissolved. Is not this fact an additional support to the theory of symbiosis, a symbiosis not strictly between the nucleus and the cell, but between the nucleus and the archosome, or microcentrum? If we should extend

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centrosomes and other structures in the cell remained dormant and separate.

This connection of the archoplasms in two adjoining cells can, I think, best be explained as a necessary conjugation—a preparation for the final mitosis of the cell. It is well known that such conjugations of nuclei have been observed in infusoria, and it has been proven to be an indispensable rejuvenation of the cell. The conjugation of the archoplasms is probably a similar necessity—a rejuvenating process without which, perhaps, a degeneration of the archosome would ensue. In connection with this I will also call attention to the observations of K. v. Kostanecki and A. Wierzejski ("Ueber das Verhalten d. sog. achromatischen Substanzen," etc.), Arch. f. Mik. Anat., Bd. 47, 1896, Heft. 2). These investigators have shown how in the fertilized ovum of *Physa* the centrosome (archoplasm and centrosome) separates from the sperm nucleus and traverses the egg cell in a very independent way (figs. 3, 9, 12, 13). This shows according to my judgment that in the above case the archosome is to a great extent independent of the nucleus; but even a greater proof of the independence of the archosome is found in a most important treatise on the Spermatogese von *Paludina vivipara*, by Professor Leopold Auerbach (Jenaische Zeitschrift, Bd. 30, 1896, Heft. 4). This admirable memoir arrived just as I was reading the final proof of the present paper, and time will not permit of my making more than a review of the summary of results. *Paludina vivipara* produces two kinds of spermatozoa: one possessing the regular form and structure consisting of nucleus and cytoplasm, and probably archosome also; the other kind, which has been known as the worm-like form, contains no nucleus, but is composed principally of cytoplasm. It has the value of a Nebenkern. The chromosomes of the original nucleus are being destroyed or ejected, and the Nebenkern, together with part of the cytoplasm, develops into an independent spermatozoon. In the figures (13a to q) of Professor Auerbach, I find nothing which resembles a centrosome or archoplasm, but I think

there can be no doubt as to the homology of my archosome with his Nebenkern, and also with his wormlike spermatozoon. The absence of any differentiation of spheres in his Nebenkern is probably due to the stains used or to the fixatives, my own experience being that Säurefuchsin does not differentiate the archosomal spheres, but on the contrary covers up their finer structure. I am confident that with proper toluidine staining the wormlike spermatozoon of *Paludina* will show a structure not brought out by the coarser fuchsin; however, enough is shown in Auerbach's figures to satisfy me that we have here a real case of independence of the archosome, and I am confident that further investigation will show an undoubted homology of the wormlike spermatozoon of *Paludina* and the plasmocyte of the blood of *Batrachoseps*.

At the time I was reviewing the above mentioned monograph by Professor Auerbach, my attention was called to a most interesting paper on "The Sexual Phases of *Myzostoma*" (*Mittheilungen a. d. Zoolog. Station z. Neapel.*, Bd. 12, 1896, Heft. 2), by Dr. Wm. M. Wheeler.<sup>1</sup> In this paper Dr. Wheeler figures certain bodies, living free in the body cavity of *Myzostoma*, which he describes, provisionally at least, as parasitic amœbæ, under the name of *Amœba myzostomatis*. The body of this amœba is at various places produced into fine points, one of which is seen to penetrate the cytoplasm of the ovum of the *Myzostoma*. In other respects the parasite is entirely external to the ovum. The fine needlelike point of the amœba pierces the ovum more or less deeply, and always from the side furthest away from the nucleus of the ovum, at least so it appears in the figures. The region of the cytoplasmic part of the ovum in the immediate vicinity of the inserted point exhibits a most remarkable radiation: as Dr. Wheeler says, "not unlike an astrosphere at the pole of a karyokinetic spindle." This

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<sup>1</sup> I am under great obligations to my friend Professor Herbert P. Johnson, of the University of California, for having attracted my attention to the remarkable amœboid bodies described in Dr. Wheeler's paper.

astrosphere lies very nearly in the position which we should expect to find occupied by the archosome of the ovum. Occasionally amœbæ were found which were not in the act of puncturing the ova; while in a few instances a single amœba was seen which had two points, each entering the body of an adjacent ovum.

As to the structure of the amœba, Dr. Wheeler says, "Each contained, besides a number of deeply staining irregular granules, a pale round body, which I hesitate to interpret as a nucleus, although it is certainly remarkable that no other structure comparable to a nucleus could be found in these amœboid organisms, when they had been treated with such an excellent nuclear stain as Heidenhain's iron hæmatoxylin." I think that the absence of a nucleus indicates that this body is not an amœba, but something entirely different; and the question now arises, must we not in this so called amœba recognize a free and independent archosome? The pale round body would then be interpreted as a somosphere, and the irregular, deep-staining bodies as centrosomes. An objection to this interpretation of the dark, irregular granules might be made on account of their position, situated as they are outside of the somosphere; but this may be only a temporary position such as occurs also in the plasmocyte, where the centrosomes now and then are found outside of the somosphere, being free in the centrosphere. In the ova figured by Dr. Wheeler we find no trace of any other archosome, but are told that the cytoplasm of the ova attacked by the amœba contained large granules which are larger and more numerous than those which occur in the normal ovum at about the same stage. These granules take up the hæmatoxylin with avidity. Judging from the figures (Taf. 10, fig. 23, and Taf. 12, fig. 56) these granules in the ova are exactly similar to those in the resting amœba (fig. 56). In the entering amœba these granules as well as the pale round body are absent. It appears to me as if the pale round body, or somosphere, and the granules, or centrosomes, had been injected into the ovum by the free archosome. If this interpretation of the

nature of this amœboid body is proved to be correct by future investigation, then we shall have here the third known instance of a free and independent archosome, the other two being the plasmocyte in the blood, and the wormlike spermatozoon of *Physa*.

If we now consider the budding of the centrosomes as shown by Heidenhain, and that of the plasmocyte as shown by me, does it not demonstrate that the centrosphere and centrosomes are in reality distinct and independent elements, though as yet we cannot in all cases know them to be independent of each other? Does it not appear also possible that these two structures once existed separately but later on joined in a symbiotic existence, long before the archosome as a whole had joined the caryosome and cytosome to make up the present cell?

*Identification of the Spheres.*—I believe it will prove of interest to attempt an identification of the cytoplasmic zones of the plasmocytes and plasmocytoblasts with those observed in perfect cells. Such identification is for several reasons by no means easy. Many investigators have not named the respective cytoplasmic zones observed by them, and, in cases where names have been given, they have frequently used descriptions or descriptive names which are not translatable from one language to the other. Another obstacle is found in the different stains used to differentiate the respective zones. The various fixatives which are supposed to preserve the elements of the cell in their original appearance undoubtedly frequently accomplish the very opposite, at least with certain parts. Every cytologist knows only too well how differently the stains act after different fixatives have been employed. I will not dwell particularly upon the advantages of the methods I have employed in my investigations in this case, but will observe only this, that whatever changes the cytoplasmic zones may have undergone, they are not resultant from the use of violent chemicals.

There is no reason to suppose that we should find a similar grouping of cytoplasm in every cell, even when the cells belong to the same cell species, but in related

cells we must expect to find the same general cytoplasmic characters. While the leucocytes have received much attention from a host of investigators, the finer structure of the erythrocytes has hardly been touched upon. This is greatly due to the interference of the hæmoglobin, which does not permit the ready staining of the cytoplasm in any way that would permit a study of the finer details. Heidenhain's fig. 16 ("Neue Untersuchungen") demonstrates this. We see polar projections resembling plasmocytoblasts at each end of the nucleus, faintly visible at the upper end, a little more sharply defined below. The two centrosomes at one pole are strongly brought out, but the respective spheres are not to be seen.

Adolf Dehler, who has made a careful study of the centrosomes of the chicken erythroblasts, gives us as little information on this particular subject as does Heidenhain. His figures show only sharply defined centrosomes surrounded by a light colored circular sphere. MacCallum's figures show few if any exact details, except the mere outlines of the frayed plasmosphere. E. J. Claypole gives no details of any kind. In our comparisons we must, therefore, turn to other cells, among which there are few which have been more carefully studied than have the giant cells from the bone marrow of the rabbit by M. Heidenhain; and, as regards the cytoplasmic parts they show several points of similarity to our plasmocytes and plasmocytoblasts, we will consider them more particularly.

The concentric arrangement of the cytoplasm, so forcibly pointed out by Heidenhain and Lenhossék, is equally distinct in our plasmocytes. As is known, Heidenhain recognizes three distinct zones of ectoplasm, and, similarly, three distinct zones are found in the ectoplasm of the plasmocyte. How far Heidenhain's outer, inner, and middle layers correspond with the three outer spheres of the plasmocyte is more difficult to determine.

Judging from the form, situation, and staining quality, I believe it safe to identify the outer zone of Heidenhain's ectoplasm with my plasmosphere. The identity of my hya-

losphere with Heidenhain's middle zone is, however, not apparent, and is rather improbable. This middle zone stains strongly and is plainly granulated, while my hyalosphere stains poorly and is characteristically homogenous, appearing like an even, pellucid ring. When we turn to the granosphere we can hardly identify it with Heidenhain's inner zone of ectoplasm, this zone staining faintly, while my granosphere stains deeply. If, again, we consider the position of the inner zone, we find that it surrounds the nucleus, being in actual contact with it, unlike my granosphere but similar to part of my hyalosphere. On account of its staining quality and general appearance I think that my granosphere may be more properly identified with Heidenhain's middle zone. If this is so it is probable that my hyalosphere was originally confined to the vicinity of the nucleus but later pushed itself between the plasmosphere and the granosphere. Heidenhain's endoplasm cannot be taken into consideration as it is only an invagination of the ectoplasm. The innermost spheres in the plasmocyte I can compare only to Heidenhain's microcentrum, though it must be conceded that the analogy is not absolutely certain. Heidenhain understands by his microcentrum, not only the centrosomes but also the particular substance which surrounds and converts them, the whole forming a distinct body by itself. This connecting substance—"primary centrosmose"—must be referred either to my somosphere or centrosphere; or, what is more probable, sometimes to the one and sometimes to the other. In this paper when reference is made to the microcentrum it must be distinctly understood that I leave this point undecided. By microcentrum I mean the centrosomes together with the nearest visible sphere surrounding them and connecting them with each other. In Heidenhain's figures the divisions of the microcentrum are less distinct from each other than they are in the plasmocytes. The distinction between the granosphere and the centrosphere is always very good, especially in successful stains with eosin, as shown in figs. 49, 59, or even 48; and even with toluidine the differentiation is

often striking, as, for instance, in fig. 65. The somosphere is probably identical with the faintly staining sphere surrounding the microsomes in Heidenhain's figs. 37, 39, 48, 49, 53, etc.

If we compare our cytoplasmic spheres with the ganglionic cells of the frog, as described by Lenhossék, we find several points of similarity. Lenhossék endeavored to harmonize the cytoplasmic spheres seen by him with those of other investigators, and met I think with some success. He divides the cytoplasm into two main divisions; an outer one, for which he proposes the name plasmosphere or perisphere, and an inner division which he refers to as centrosphere, the latter being sharply defined like a second nucleus. This agrees exactly with the centrosphere of the plasmocyte, and I have for this reason adopted the name proposed by Lenhossék for this highly individualized part. The centrosphere of Lenhossék is frequently surrounded by a white ring, a fact which I, too, have observed at times in the plasmocytes. A study of Lenhossék's figs. 5, 6, 7, and 9 shows that the minute centrosomes are surrounded by a dark film which I identify with my somosphere. As regards the plasmosphere of the ganglionic cells the agreement is less apparent, except that the cytoplasm is prominently concentric and consists of at least two, probably three, distinctly differentiated zones, which, however, are not strictly localized. Of these the inner zone is granulated, while the middle one (Lenhossék, *Tafl. xv, fig. 3*), stains even more intensely than the granosphere of the plasmocyte. In the ganglionic cell as well as in the plasmocytoblast it is the "grosse gekörnte Protoplasmaschicht" which causes the dell in the nucleus, a fact which when coupled with other similarities warrants my identifying these two zones with each other.

In one of the very latest contributions to cytology, Dr. O. Van der Stricht has described cell structures which bear a marked resemblance to those of the plasmocytoblasts. In his figs. 19, 20, 21 and 22, but especially in 19 and 20, we find a most striking arrangement of the cytoplasm. It be-



comes at once evident that the dark-staining granulated zone can be identified with my granosphere. It possesses the following qualities in common with the granosphere: It stains darkly; it is granulated; it encloses the microcentrum; and it is crescent-shaped, the cavity of the crescent joining a light colored zone, which latter partly or entirely surrounds the nucleus, as does my hyalosphere. The microcentrum also is in almost every particular similar to the archosome of the plasmocytoblast. In one of the figures (21) the granosphere is seen to cause a dell in the nucleus, a characteristic which renders nearly perfect the similarity. We must suppose that in these cells the hyalosphere if present is confined to the immediate vicinity of the nucleus, where it is recognizable as a faintly stainable ring. In the paper referred to (pages 257, 258) Van der Stricht has undoubtedly recognized the great importance and prominence of the granosphere, stating that the first modifications apparent in the microscope take place in the very compact cytoplasm which surrounds the attraction sphere. He further states that this "granulated zone" probably corresponds to the asteroid region surrounding the attraction sphere in the egg, or to Heidenhain's radiating organic fibers, with which I am ready to agree. This zone has also been recognized and figured by Hermann, A. Prenant, Holl, F. Heneguy, Van Bambeke, and H. Mertens, as was pointed out by Van der Stricht. Among other recent investigators who have recognized the importance, or rather the existence, of the archosome, R. von Erlanger takes a prominent place. In his paper on the testes of the earthworm he describes and figures the archosome and granosphere which he designates as *Nebenkern*. He recognizes the centrosome as being situated in this body and ascribes to it a distinctly cytoplasmic origin. While this *Nebenkern* and my archosome and granosphere are undoubtedly homologous, it must be remembered that the *Nebenkern*, or paranucleus of some other investigators, signifies bodies of a very different nature and sometimes even foreign to the cell. Erlanger compares his *Nebenkern* in the sperm cells with similar

structures described by Bütschli and v. la Valette, and calls attention to the great resemblance between them. From this we may conclude that of the cytoplasmic spheres described by me above, the granosphere is the most constant, probably existing in all the cells.

The large granular spheres which have been described by Meves from the achilles tendon of the frog must also be considered identical with some of the spheres of the plasmocyte. Meves describes the large outer sphere—my granosphere—as concentric layers of indistinct granules which might be considered as membranous formations surrounded by thin homogenous cytoplasm. There can be little doubt that the above structure is identical with my granosphere, in which similar concentric layers are frequently observed (Meves, Taf. ix, fig. 2, etc.). In his fig. 10 there appears a pale uncolored sphere surrounding the centrosomes (but inside the centrosphere), which probably corresponds to my somosphere. We must remember that Meves used iron stain which does not differentiate as well as the toluidine.

Especially as regards the somosphere, I think that future investigations will demonstrate its presence in the microcentrum of many cells, and that many structures which have been described as centrosomes will, when subjected to closer examination, be referred to the somosphere; for instance, the branched centrosomes in the pigment cells described by Zimmermann. A real somosphere has been observed by Häcker in the winter egg of *Sida crystallina* (loc. cit., Taf. xxi, fig. 1), which he calls after Strassburger "tingirbare innenzone." The increase in size and growth of the centrosome in *Sida* is also pointed out by Häcker, a growth which is probably analogous to the growth of the somosphere in the plasmocyte.

Whether there exists any homology between the plasmocytes and the paranuclei described by Bremer from the blood of *Testudo carolina* must remain undecided. Judging from the figures accompanying Bremer's paper, as well as from his descriptions, the paranuclear bodies are much

less regular than any of the plasmocytoblasts from the blood of *Batrachoseps*. How much of this is due to the fixing chemicals used in Bremer's preparations cannot be known until comparative studies have been made with non-fixed blood. The peculiarly shattered nuclear structures would, it seems to me, certainly indicate that the paranuclear structures also had been considerably disturbed before finally being fixed. A further study of these paranuclei is certainly of the highest importance. I have seen somewhat similar bodies in the blood cells of *Diemyctylus* and *Chondrotus*, but not in *Batrachoseps*.

The peculiar structureless bodies described by Rawitz from the lymphatic gland of *Macacus* (Arch. Mikr. Anatomie, Bd. 45, page 592) are possibly of the same nature as my archosomes or plasmocyte. The want of structure may be due to imperfect fixing methods employed. These bodies occupy the same position in the cell as the *Neben-kern*. The fact that they are set free in the lymph and probably reach the general circulation makes an homology between them and the plasmocytes probable.

*Plasmocyte and Leucocyte.*—It is appropriate that we should compare the plasmocyte with the leucocyte in the same blood, and search for some similarities as regards the inner spheres. At the outset we find some very marked differences pertaining to their staining qualities. Thus we find that the Ehrlich-Biondi mixture, which is the most successful stain to bring out the microcentrum of the leucocyte, fails entirely to give any satisfactory images of the corresponding parts of the plasmocyte; and, *vice versa*, the toluidine does not stain the microcentrum of the leucocyte, neither the spheres nor centrosomes. Another striking difference between the two kinds of corpuscles is the absence of cytoplasmic rays in the fusiform corpuscle. Although carefully looking out for any trace of them I have failed to find them in the plasmocyte. Now and then a star-shaped granosphere occurs, both in the plasmocyte and in the plasmocytoblast, but they are quite different from the filaments in

other cells and do not appear to have any other function than that of locomotion.

The dark-staining, starlike sphere of the leucocyte, as seen in figs. 14, 15, 16, 18, and 19, is probably homologous with the granosphere of the plasmocyte; it is the sphere which causes the dell in the nucleus of the leucocyte. The inner pale sphere surrounding the centrosomes in the leucocyte would then correspond to the centrosphere of the plasmocyte. In leucocytes stained with toluidine the granosphere is only brought out by several hours of exposure to the stain. This exposure will invariably injure the differentiation of the plasmocytes and plasmocytoblasts but it will bring out the granosphere most beautifully, as seen in figs. 16*b*, 18*b*, and 19*a*. It will be seen that a ray extending from the archoplasm is covered by different microsomes at different points in the cell. Thus the innermost microsomes consist of particles of granosphere, while the outer ones consist of granules of plasmosphere or blue-staining cytoplasm.

In fig. 18*b* the archosome has divided into several smaller semiglobular parts, but the toluidine has not differentiated any of its zones nor stained the centrosomes.

*Unclassified Corpuscles in the Blood.*—Among the plasmocytes I frequently find spherical or oval bodies as large as the smallest plasmocytes. They resemble small nuclei, and when stained with toluidine are semitransparent, with darker streaks like marbled veins. They contain neither layers, spheres, nor globules, and their nature is doubtful.

#### SUMMARY.

1. The erythrocytes in the normal blood of *Batrachoseps* vary greatly in size and shape, much more so than those of any other known animal. They are in this respect entirely unique. The smallest are smaller than the red corpuscles of the human blood, while the largest are seven times their diameter. This refers not only to the nucleated, but also to the non-nucleated erythrocytes.

2. The vast majority of the erythrocytes are not nucleated, hardly any being found in the spring of the year. In the summer and autumn they are more numerous than at any other time. In this, also, *Batrachoseps* stands alone; all other batrachians possessing only nucleated red blood cells, at least according to our present knowledge.

3. A perfect nucleated erythrocyte of the blood of *Batrachoseps* consists of three distinct and separately organized parts, which, however, are not of equal importance in the general make-up of the cell. These parts are the Cytosome, consisting of three cytoplasmic spheres—plasmosphere, hyalosphere, and granosphere; the Archosome, consisting of three archoplasmic spheres—centrosphere, somosphere, and centrosomes; and the Caryosome, or nucleus.

4. The observed facts further verify the theory that the fusiform corpuscles are the remains of nucleated erythrocytes which for some reason have lost their cell wall and hæmoglobin. This fusiform corpuscle is thus newly ejected nucleus to which is yet attached most of the cytoplasm of the cell.

5. At and after the separation of the fusiform element from the rest of the cell the archosome remains in the fusiform element until the plasmocyte is formed.

6. The origin of the fusiform corpuscle is due to a defect in the nucleus, or more particularly in the chromosomes. This defect has prevented the chromosomes from assuming the preliminary skein stage preparatory to division. The archosome, which has already entered upon the second stage of mitosis, having divided and moved to opposite poles, cannot, therefore, conclude the process, the energy expended effecting only the rupture of the cell membrane, thus setting free the fusiform element.

7. The fusiform corpuscle consists of the nucleus and one or two plasmocytoblasts,<sup>1</sup> each one of which consists of six cytoplasmic zones, including centrosomes.

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<sup>1</sup> In the foregoing, and throughout this paper, I have used the word plasmocytoblast in order that I may be clearly understood; but for the sake of brevity I propose that this word be made simply plasmoblast.

8. The plasmocytoblast is capable of development and division into two, three, or more plasmocytes, which finally separate from the nuclear vicinity, each one forming a free and independent active plasmocyte in the blood serum.

9. The plasmocyte undoubtedly survives in this state for a considerable length of time and must take rank with the other principal and active corpuscles in the blood, the erythrocytes and leucocytes.

10. The plasmocyte is capable of growth through assimilation of food and exhibits phagocytosis. It contains the same cytoplasmic zones as are found in the plasmocytoblast but has no nucleus.

11. The determining part of the plasmocyte is the archosome, or centrosomes with spheres, as without them the plasmocyte is not formed. Imperfect plasmocytoblasts, or such as do not possess an archosome, do not develop plasmocytes.

12. The non-existence of attraction rays is probably explained by the absence of a cell wall.

13. The nucleus of the fusiform corpuscle goes quickly to decay, no part of it surviving in the plasmocyte.

14. The archosome is not merely an organ in the cell—a large microsome formed for the special purpose of mitosis—but constitutes a most important element of it, the very center of organization, equal in importance to the nucleus itself. The archosome can no more be said to originate in the cytoplasm than it does in the nucleus. The only connection the archosome has with the cytoplasm is that of resting in it and of being partly nourished by it. That the centrosome is at times found in the nucleus, as has been shown by Brauer and Lauterborn, does not imply that it originates in the nucleus, but simply that in some instances it temporarily resides there. The archosome possesses the same individuality whether residing in the cytoplasm or in the nucleus.

15. The survival of the archosome, with its phenomena of growth and phagocytosis, and its general independence, suggests a symbiosis between the archosome, the caryo-

some, and the cytosome; but of course I do not claim that it proves it. The effect of such a symbiosis would be, among other things, to create a cell membrane and cell division by mitosis. I favor this theory because it explains the survival of the archosome (surrounded by cytoplasmic envelopes) as an independent corpuscle.

16. The new plasmocyte in the blood of *Batrachoseps* may then be defined as a corpuscle, generally without a cell wall and always without a nucleus; but consisting of the archosome, which has surrounded itself with the three outer spheres of cytoplasm, and which survives as an independent corpuscle in the blood serum. It is capable of growth and assimilation of food, and to some extent of amœboid movements. The archosome itself contains three separate spheres, inclusive of the centrosomes. The plasmocyte possesses the following properties: organization, growth, assimilation of food through phagocytosis, motion, both as a whole and by the individual inner spheres, and, finally, sensitiveness, shown in selecting a certain quality of food (erythrocyte fragments and bacteria).

17. The plasmocytes are derived from the red blood cells and not from the leucocytes. The archosome of the leucocytes does not survive, but disintegrates at the same time as the balance of the leucocyte.

18. The granosphere is the seat of phagocytosis and must be considered as the digestive organ of the cell and the plasmocyte, and the storehouse for accumulated food. The somosphere is probably the assimilative organ of the archosome and especially of the centrosomes. The hyaline globules frequently found in the somosphere I consider as food supply. The process of assimilation would then be as follows: The food, derived from the blood serum and through phagocytosis, is digested and assimilated by the granosphere for the benefit of the plasmocytes at large. This food supply when accepted by the archosome is further digested by the somosphere for the special benefit of the centrosomes.

From this we may conclude that the granosphere is a con-

stantly recurring zone in the cell and that it is quite easily recognized. Wherever it occurs it seems to possess the same characteristics as regards form, granulation, and staining capacity, and it appears to be a most important element of the cell, probably of secretive, digestive, and assimilative function. The archosome has been recognized in a great number of cells and parts of it have been described under several names: first, I believe, as *Nebenkern*; later on, as *microcentrum*, etc. The *centrosphere* has been observed in many cells and is variously termed *archoplasm*, *attraction sphere*, *centrosphere*, etc. The *somosphere* has been figured as surrounding the centrosomes, but previous to this it has not been named nor has any function been assigned it.



MEASUREMENTS OF THE CORPUSCLES AND THEIR SPHERES,  
CALCULATED BY PROF. GEORGE OTIS MITCHELL.

NUCLEATED ERYTHROCYTES.

Large nucleated erythrocyte.....	24. 9 mm.
Round nucleus of erythrocyte.....	18.26 mm.
Large round nucleated erythrocyte.....	33. 2 mm.

NON-NUCLEATED ERYTHROCYTES.

Long form.....	46.48 mm.
Average round .....	16. 6 mm.
Small round.....	9.96 mm.
Very small.....	6.40 mm.

FUSIFORM CORPUSCLES.

Nucleus of corpuscles.....	24. 9 mm.
Cytoplasmic projection, or plasmocytoblast:	
at upper end.....	4.15 mm.
at lower end.....	2.49 mm.
Very large nucleus, almost square.....	19.92 mm.
Plasmocytoblast of fusiform corpuscle.....	9.96 mm.

LEUCOCYTES WITH POLYMORPHOUS NUCLEI.

Large size.....	33. 2 mm.
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ROUND MONONUCLEARY LEUCOCYTES.

Average.....	12.28 mm.
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EOSINOPHILE LEUCOCYTES.

Large, but not largest.....	19.92 mm.
Average .....	14.94 mm.

PLASMOCYTES.

Average, with two microcenters.....	6.64 mm.
Average, with one microcenter.....	6.60 mm.
Large.....	8. 3 mm.
A very long one: Plasmosphere.....	14.94 mm.
Centrosphere.....	9.96 mm.
Ovoid form: Plasmosphere.....	8.30 mm.
Centrosphere.....	4.98 mm.
Small: Plasmosphere.....	3.32 mm.
Centrosphere.....	1.66 mm.
Large round Plasmocyte: Centrosphere.....	4.98 mm.
Outside of plasmosphere.....	14.11 mm.
Outside of hyalosphere.....	8.30 mm.
Total.....	14.11 mm.
Large ovoid: Plasmosphere.....	11.62 mm.
Hyalosphere.....	8.30 mm.
Centrosphere.....	4.81 mm.

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## EXPLANATION OF THE FIGURES.

Figures 1-47, 50-78 have been drawn from Zeiss  $\gamma$  hom. im., with oil immersion contact between the Abbe condenser and the underside of the slide. Ocular 2.3.4. Figures 44, 48, 79-84 have been drawn from Zeiss apochrom. 3 mm. Ocular 12 and 18. Both daylight and gaslight were used. The images were projected on the working table, outlines drawn with camera, details filled in. They are from cover-glass preparations fixed with absolute alcohol.

All the figures are from elements in the blood of *Batrachoseps attenuatus*.

## PLATE I.

## NON-NUCLEATED ERYTHROCYTES.

1 to 6. Six non-nucleated erythrocytes of different forms and sizes. Ehrlich-Biondi. Oc. 2.

## NUCLEATED ERYTHROCYTES.

7. Large round erythrocyte with distinct bipolar nucleus.
- 8-9. Smaller erythrocytes with oblong nuclei.
10. Large erythrocyte with large nucleus. Above four, Ehrlich-Biondi.
11. Round erythrocyte, Ehrlich's neutrophile stain.

## EOSINOPHILE LEUCOCYTES.

12. Average size. Ehrlich-Biondi. Oc. 3.
13. Larger. Ehrlich-Biondi. Oc. 3.

## POLYMORPHOUS LEUCOCYTES.

All stained with Ehrlich-Biondi and washed with oxalic acid solution in water. (Except 18b and 19, which are toluidine stains.) Oc. 3.

14. The granosphere is starlike and encloses an archosome with two centrosomes separated by a light colored bar.

15. The granosphere is less distinct, and the archosomes are entirely separated, one containing two, the other one centrosome.

16. The granosphere is small but distinct, rounded in outline. The two archosomes are separated.

17. Granosphere not distinct. Three archosomes, one of which has two centrosomes.

18a. The center of a leucocyte; the nucleus is not figured; the granosphere is starlike; the archosome is round, with three centrosomes of unequal size. Ehrlich-Biondi.

18b. The center of a leucocyte; the nucleus not figured; the granosphere is stained pink; the cytoplasm is bluish; the archosome is not entire, but is broken up into several semiglobular zones; centrosomes not stained. Toluidine.

18c. A leucocyte with three separate archosomes. Ehrlich-Biondi.

19a. A large polymorphous leucocyte; granosphere is stained pink; two centrosomes. Toluidine.

19b. A large leucocyte with pink granosphere. Centrosome not stained. Toluidine.

20. A mononuclear leucocyte stained with Ehrlich-Biondi, the deep staining showing presence of hæmoglobin.

## FUSIFORM CORPUSCLES WITH PLASMOCYTOBLASTS—21 TO 39.

All are stained with toluidine, excepting fig. 36, which is stained with Ehrlich-Biondi. In the following the plasmocytoblasts will be referred to simply as pcb.

21. The nucleus is rounded and in a fair state of preservation as regards the outline. There is only one pcb. at the upper pole (*a*), showing the spheres arranged as cones, one above the other. The smallest and lowest down is the somosphere, in which are seen three dark separated centrosomes. All the spheres, except the plasmosphere and hyalosphere, are stained violet, the latter are blue or bluish. At the lower pole (*b*) is seen a crescent-shaped fragment of granospheroplasm, also stained violet. The plasmosphere and hyalosphere extend around the left side of the nucleus, but cannot be traced along the entire right side. Oc. 3.

22. The nucleus shows advanced degeneration; the plasmosphere and hyalosphere extend all around. At the upper pole the archosome has advanced far upward into the crescent-shaped large granosphere. Here is seen one centrosome. At the lower pole an indistinct archosome is visible. The nucleus shows a distinct polarity, the pole being marked with a white spot. Oc. 2.

23. The nucleus shows a strong polarity. At the upper pole is a large pcb. in which the granosphere is very narrow, stained violet. The whole archosome is far advanced. The centrosphere is almost unstained. The somosphere is large, with two distinct centrosomes. At the lower pole there is a crescent-shaped granosphere without archosome. Oc. 2.

24. The nucleus is in an advanced state of degeneration. A plasmocyte is nearly ready to separate at the upper pole, having left a crescent-shaped residue of granosphere. A similar crescent of granosphere is seen at the lower pole, but without archosome. Oc. 2.

25. The nucleus is in an advanced stage of disintegration. The upper pole contains a pcb. which has changed into a plasmocyte which is almost ready to separate. The lower part of the pcb. has not yet perfected the outlines of the spheres. There is no residue of granosphere, and only one archosome. At the lower pole there is no pcb. nor any residue of granosphere.

26. The nucleus is rounded and swollen, with indications of a strong polarity. The upper pole contains one pcb. with distinct centrosomes and a starlike centrosphere. Plasmosphere and hyalosphere indistinct.

27. The nucleus is in fair state of preservation, showing a polarity. At the upper pole is a very large pcb., with the archosome far advanced towards the apex. The plasmosphere and hyalosphere are distinct all around the corpuscle. Oc. 3.

28. There are three archosomes in the pcb. at the upper pole, and one indifferently developed pcb. at the lower pole. Oc. 2.

29. There is a pcb. at each pole. The archosome is far advanced, and the spheres are differentiated. Each archosome contains two centrosomes.

30. Very similar to fig. 29, but the centrospheres are stained deep blue, while in the former they were white.

31. There is a pcb. at either pole. The archosome at the upper pole

is more advanced than the one at the lower pole. The two outer spheres are not well differentiated. Oc. 2.

32. There is a pcb. at each pole. The granosphere is everywhere violet. In the upper pcb. it is cone-shaped, the archosome is moving upwards. The centrosphere is pale white and very narrow. The somosphere is deep blue, with darker centrosomes. The lower pcb. is much further advanced than the upper one. The granosphere is starlike, and the centrosphere is more distinct than the one in the upper archosome. The upper archosome contains three centrosomes, the lower one apparently but one.

33. The pcb. are very large, but the inner spheres are not well differentiated. In the upper pcb. (a) there is only one archosome, while in the lower (b) there are three archosomes. Oc. 4.

34. Two pcb., one at each pole. The one at the upper pole is more advanced than the one at the lower pole. The centrospheres are white, the somospheres blue, and the centrosomes dark blue. Oc. 4.

35. There are two pcb., one at each pole. The granospheres are light violet, the centrospheres deeper violet, while the somospheres are pale. In the upper somosphere we see two separated centrosomes, while in the lower one (b) they are too close to be distinguished. Observe the star-shaped centrosphere at the upper pole, while the one at the lower pole is conelike. The former is probably an indication of amceboid movement.

36. There are two distinct pcb., but only the upper one is of normal size. This one contains three separate archosomes, each surrounded by a concentrating granosphere, and each with a single centrosome. The lower pcb. has spread out, enclosing about half the circumference of the nucleus. In this lower pcb., also, the archosomes have separated, each having a single centrosome. The pale spheres are probably centrospheres. The nucleus is in fair preservation, showing a strong polarity. Ehrlich-Biondi. Oc. 3.

37. This is a very large nucleus with a dissolving pcb. at the pole. Probably the two poles have been brought together, at any rate, the appearance is a very irregular one. There are three growing plasmocytes in various stages of development. The lowest one is almost ready to separate as a fully developed plasmocyte, containing apparently three archosomes. The young plasmocyte to the left is the least advanced of all; the nucleus is in a high state of disintegration and unusually swollen. Oc. 3.

38a. In the fusiform corpuscle the lower pcb. has almost separated, and the independent plasmocyte is all but ready. It is connected with the fusiform corpuscle by a long narrow shaft of plasmosphere. It contains two archosomes, the lower one of which is much the larger. The granosphere is narrow, and differentiated deep blue. The centrosphere is very large and pale blue, containing a paler white zone with a few darker rays and a few small central bodies. The large inner white zone is not easily explainable, except as a part of the centrosphere. The dark round spot at the lower margin is also of doubtful nature. The smaller archosome contains a distinct centrosome. There is a residue of crescent-shaped granosphere at the lower pole. The upper pcb. is probably dormant.

## PLATE II.

38b. The plasmocyte is almost ready to separate. The nucleus is in a far advanced stage of decomposition. The centrosphere contains three very distinct centrosomes; there is no somosphere.

39. The plasmocyte is almost fully developed; there is a residue of crescent-shaped granosphere at the pole; only part of the nucleus is indicated. The plasmocyte contains two archosomes, one of which is imperfect, but with a distinct centrosome. In the larger plasmocyte the granosphere is dark violet; the centrosphere pale violet, with a dark somosphere. There are parts of somosphere and centrosomes scattered along the edge of the centrosphere, as is sometimes the case. The pale ring around the granosphere is the hyalosphere.

## PLASMOCYTES.

All these figures are shown with Oc. 4, excepting 46, 50, 51, 58 and 76. The stain used for most of the figures was toluidine; Ehrlich-Biondi for 54, 62, 67, 78; eosin-methyl blue "O" for 48, 49, 59; and for figures 82, 83 and 84 Zeiss Apochrom.

40. The granosphere is very long, and the hyalosphere is much wider than is generally the case. The pale violet, almond-shaped zone in the darker granosphere is the centrosphere. The centrosomes and somosphere are not segregated. The thin blue fringe along the margin is the plasmosphere.

41. Showing a long, armlike, amoeboid projection. The hyalosphere is not differentiated; the granosphere is deep violet; the centrosphere is round and white, with a central centrosome. There is a small centrosome with centrosphere, but without granosphere, in the lower right margin.

42. A plasmocyte, crescent-shaped, with two archosomes, but only one granosphere. The inner spheres are not well differentiated.

43. A starlike plasmocyte with poorly differentiated archosomes. It is probable that these two figures, 42 and 43, as well as 78, represent plasmocytes in degeneration, none of the spheres having properly responded to the stains.

44. A very perfect plasmocyte with well differentiated spheres. The granosphere is dark violet and contains two archosomes, the upper one of which is very small; the lower one is large, with a very large oval centrosphere, which shows different layers of plasma; in the center is a square somosphere with four centrosomes.

45. A large, starlike plasmocyte, with a dark, round granosphere. The centrosphere, which is differentiated and irregular, is seen at the lower margin; it contains blotches of somosphere and a round, ringlike centrosome.

46. A starlike plasmocyte with dark and narrow granosphere. The large, paler, inner zone is the centrosphere, and the innermost darker zone is the somosphere with centrosomes.

47. A very perfect plasmocyte, with a narrow rim of violet granosphere. The centrosphere is very large, stained pale blue. The inner somosphere is pale whitish, with a few, small centrosomes in the center.

48. This is a somewhat abnormal, but well differentiated plasmocyte. Eosin-methyl blue "O." The hyalosphere is pure white. The large, pale pink zone is of doubtful character, possibly only part of the hyalosphere. In

this case the granosphere is a very narrow, deep blue zone, which surrounds the large, paler blue centrosphere. The somosphere is dark blue, with a bright pink and very large food-granule. The explanation of these spheres is, however, only tentative.

49. A very typical plasmocyte. Eosin-methyl blue "O." The hyalosphere is pink; the granosphere deep blue; the centrosphere is large and pink, while the inner somosphere is starlike and blue, with a few dark centrosomes.

50. The principal interest in this figure is the starlike centrosphere, containing a few dark centrosomes. Compare fig. 26, where a similar form of centrosphere is seen.

51*a* and *b*. Two starlike plasmocytes. In *a* the granosphere is very narrow and the centrosphere very large. In *b* the archosome is not well differentiated.

52. A round plasmocyte, well differentiated, but not deeply stained. The pale, rather poorly defined centrosphere contains three very distinct centrosomes of different sizes.

53. The granosphere contains two distinct zones, the inner of which is deep violet. The centrosphere is paler violet. The darker center is the somosphere, with a few very indistinct centrosomes.

54. Stained with Ehrlich-Biondi, showing poor differentiation. The centrosomes lie at one edge of the oblong centrosphere.

55. A fully grown plasmocyte. The granosphere contains concentric layers of denser cytoplasm. The centrosphere is denser violet. The centrosomes are arranged in a crescent along the margin of the somosphere.

56. An oblong plasmocyte, with at least three archosomes imbedded in the granosphere. There are two small centrospheres to the left and one very large one to the right, the latter extending half across the granosphere. The large round globules must be explained as centrosomes with somospheres; the smaller, dark granules are of doubtful nature.

57. The hyalosphere is unusually large; the granosphere is violet. There is one large centrosphere, with two distinct centrosomes.

58*a*. In this plasmocyte the three centrosomes are remarkably distinct, and of different sizes. The paler sphere is the centrosphere, there being no distinct somosphere. The granosphere is deep blue, darker at the left side.

58*b*. A plasmocyte of very much the same nature as the last, only much larger. Here also the centrosomes are distinct and the somosphere is not stained.

59. I have referred to this figure in the text as possibly representing a plasmocyte surrounded by a membrane. It is remarkable in showing no frayed plasmosphere and no clearly differentiated hyalosphere. The dark blue sphere is the granosphere. The round pink one is the centrosphere. The centrosome is seen clearly in the center, as a very small dot.

60. An oblong plasmocyte with four distinct centrosomes. The granosphere is narrow and very dark; the centrosphere is paler and large; the rectangular field in the center is either only a part of the centrosphere or a greatly extended somosphere.

61. A plasmocyte with two archosomes, one of which contains two cen-



trosomes. The thin, narrow, blue zone around the centrosomes is the somosphere. Both archosomes lie in a common granosphere.

62. A plasmocyte stained with Ehrlich-Biondi. The stain has not been particularly successful, but the figure is interesting on account of the two separate centrosomes, or somospheres.

63. A plasmocyte with two separate archosomes. This plasmocyte appears to be in a state of degeneration.

64. A plasmocyte with two archosomes, or rather with two separating plasmocytes. The lower one is indifferently stained and possibly in degeneration; the upper one is most intensely differentiated, and possesses two additional spheres; probably the centrosphere stained pale blue, which has been divided up by the addition of some foreign substance.

65. A plasmocyte with two archosomes in one common granosphere. The upper archosome, which contains a single centrosome, is stained differently from the lower one. In this lower one there are three centrosomes in a crescent zone of somosphere.

66. A plasmocyte with three archosomes in a common granosphere. The paler zones are the centrospheres. The lower one of these contains a large somosphere and a centrosome.

67. Stained with Ehrlich-Biondi and unusually well differentiated for this stain. There are four archosomes, but the hyalosphere is only differentiated around one, which contains three distinct centrosomes.

68. A star-shaped plasmocyte with three large archosomes, each one surrounded by its granosphere. An additional smaller archosome, indifferently stained, is seen at the lower right margin.

69. A large plasmocyte with two archosomes, stained differently. The one to the left is more perfect, with a large irregular centrosphere, at the lower edge of which are seen two large centrosomes. This plasmocyte may be best explained as having been formed of two, joined together by the plasmosphere, as the hyalospheres are not continuous.

70. A plasmocyte with two archosomes with distinct differentiation. The one to the left contains a centrosome superposed on an erythrocyte.

71. Another plasmocyte with two archosomes, each containing a centrosome, centrosphere, and granosphere.

72. A compound plasmocyte, consisting of a common plasmosphere, and a common hyalosphere; but with three separate granospheres, each with an archosome.

73. A large plasmocyte. In the granosphere we find the centrosphere without centrosomes, but at its left upper margin are seen differently staining granules, probably foreign matter, reminding one of the brown sphere in fig. 64. The other dark patches may be explained as centrosomes and somospheres.

74. On one side of the inner white zone are seen a few dark granules of doubtful nature, possibly centrosomes. The other inner spheres are not easily recognizable.

75. In this plasmocyte the central part contains what greatly resembles chromosomes, and it is possible that there is an effort to establish a nucleus from accidental nuclear matter. There are three faintly differentiated archosomes in the common granosphere.

76. A plasmocyte observed in 0.6 per cent. salt solution, showing amoeboid projections of cytoplasm.

77. In this interesting plasmocyte the granosphere is divided by the bar-like centrosphere. Along the edge of the latter is seen on either side a somosphere, each with two centrosomes.

78. A plasmocyte in a very advanced stage of disintegration.

79. A plasmocyte showing phagocytosis. In the granosphere we see to the left two archosomes, each with three centrosomes connected by a narrow zone of somosphere. In the center of the granosphere is seen a small erythrocyte partly involved by granospheroplasm. In the erythrocyte is seen a large, round disk, a parasitic plasmodium, *Hæmapium riedyi*, common in the blood of Batrachoseps, the life-history of which I expect to publish soon.

80 and 81. Two plasmocytes with very refractive food globules in the somosphere. The centrosome and somosphere, when visible, are always situated close to the margin, never in its central mass. In this plasmocyte the centrosphere is the oblong, blue zone. Zeiss Apochrom. 3 mm., Oc. 8.

82. A large plasmocyte with three separate amoeboid centrospheres. Two of these possess a single somosphere with centrosomes, while the middle centrosphere possesses two separate somospheres. One of the somospheres is crescent-shaped and the centrosomes are in the budding stage. Zeiss Apochrom. 3 mm., Oc. 8.

83. A large plasmocyte with amoeboid centrospheres and ring-shaped somosphere. In the latter are seen three budding centrosomes connected by a thin rod of centrosomal matter. The substance enclosed by the granospherical ring is more refractive and probably composed of food supply which is being digested by the somosphere. Zeiss Apochrom. 3 mm., Oc. 12.

84. This is possibly a degenerating, intensely staining form of plasmocyte. The two outer spheres are almost disintegrated, while the granosphere is strongly and globularly granulated, staining intensely. There are three somospheres, one with budding centrosomes.

#### STAINS.

EOSIN. James W. Queen & Co., Philadelphia, U. S. A. Already mixed and in solution. Composition unknown.

THIONIN. Actien-Gesellschaft f. Anilin-Fabrikation. Berlin (66,711). 1 per cent. watery solution, with 10 per cent. alcohol.

TOLUIDINE, BLUE EXTRA. Actien-Gesellschaft f. Anilin-Fabrikation. Berlin (66,711). 1 per cent. watery solution, 10 per cent. alcohol.

EHRLICH-BIONDI. From C. C. Riedy, San Francisco. *Rubin S.* (No. 243); *Methyl-Grün-Kryst* (No. 99); *Orange G.* (3884); all from Actien-Gesellschaft f. Anilin-Fabrikation. Berlin (38,242). Solution acidified with oxalic acid.

METHYLENE BLUE "O," Patent. Badische Anilin and Soda-Fabrik. Ludwigshafen, Germany (9038). 1 per cent. watery solution, alcohol 10 per cent.

All the stains were supplied by C. C. Riedy, San Francisco. The numbers in parenthesis refer to manufacturer's order number.





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ERRATA.

Page 75, 14th line, for "*Tricha*" read *Taricha*.

" 81, 3d line, for "carbondioxide" read carbon dioxide.

" 89, last line, for "fig. 2" read fig. 3.

" 94, 22d line, for "urodelos" read urodelous.

" 99, 22d line, for "*T. cristalus*" read *T. cristatus*.

" 100, 6th line from bottom, for "*Amblystonea*" read  
*Amblystoma*.

" 101, 6th line, for "object" read objects.

" 104, 17th line from bottom, for "*Amblystomea*" read  
*Amblystoma*.

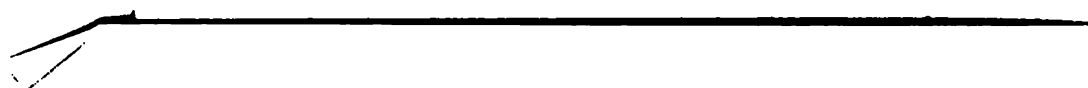
" 106, 8th line, for "*Chondrotus lugubris*" read *Chon-*  
*drotus tenebrosus*.

" 106, 17th line, for "Cadis" read Caddis.

WITH ONE PLATE.

*Issued January 18, 1897.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1897.



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DIEMYCTYLUS TOROSUS ESCH.

THE LIFE-HISTORY AND HABITS OF THE PACIFIC COAST  
NEWT.

BY  
WILLIAM E. RITTER,  
*Assistant Professor of Biology, University of California.*

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# THE LIFE-HISTORY AND HABITS OF THE PACIFIC COAST NEWT (*DIEMYCTYLUS* *TOROSUS* Esch.).

BY WILLIAM E. RITTER, PH. D.,  
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## I.—HISTORICAL.

DURING the last seventy years a number of zoologists have made observations upon and written about the amphibian to which the following pages are devoted.

It was first described by Eschscholtz ('33) under the name of *Triton torosus*. The author's introductory statement is as follows<sup>1</sup>: "Es hat dies Thier Hinsichts der Grösse, der allgemeinen Körperform, der Farbe und der Beschaffenheit der Hautdecken eine grosse Aenlichkeit mit *Triton cristatus*;" and he then proceeds to give a quite detailed com-

<sup>1</sup>I have not had access to a copy of Eschscholtz's Atlas, and am greatly indebted to my friend, Dr. T. S. Palmer, National Department of Agriculture, Washington, D. C., for a complete transcription for me of the part relating to this animal.

PROC. CAL. ACAD. SCI., 3D SER., ZOO., VOL. I.

January 15, 1897.

parison between the two species. The description of *T. torosus* which then follows contains various measurements and anatomical details, on the whole accurate and satisfactory. In a few particulars, however, I am at a loss to know how to account for his statements. Thus he tells us that the vas deferens is not white but "ganz schwarz." Of the hundreds of specimens which I have examined I have never seen a case in which the vasa deferentia were any other color than white. The point is one of no particular importance, but if such a variation occurs it is certainly very rare, and it is a little curious that Eschscholtz should have happened upon it in the few specimens that he seems to have had.

Again, he states that the testis is not divided into two or three parts by "quere Einschnürungen," but is entirely simple and oval in form. This is certainly not true in the great majority of specimens. It is almost always divided into two or three portions, distinctly and usually quite widely separated from one another.

He erred further in concluding that the openings at the summits of the black-tipped papillæ of the integument are only deceptive appearances. As a matter of fact such openings do exist, as I shall show later on.

The next naturalist to study the animal was Gray ('39). This author gives a brief description and also a figure of it. It hardly seems credible, however, that the figure (No. 3, Plate XXXI) to which he refers could have been made from a specimen of this newt. If it was, either the artist or the specimen, or both, were very unworthy representatives of their kind.

The best general figure of the species that has heretofore been published is that contained in Girard's Atlas, Herpetology, U. S. Exploring Expedition, Plate I, fig. 1. This is from a sketch from life by Jos. Drayton, and on the whole is quite satisfactory for the variational form which it represents. I have, however, never seen an individual in which there was so strong and abrupt a contrast between the orange of the underside of the trunk and the yellow of

the throat as this figure indicates. The eyes are made more prominent than they are in reality, and the pupils are represented as circular, while in truth they are elliptical, as my figures show; but this error is rectified by the author in the text.

Girard adopted for the animal the generic name *Taricha*, proposed by Gray ('50). In his description he is at fault, or at least only partially right, in several points; but it will be advantageous to leave the correction of these errors to the appropriate heads under which they will fall in the description which is to follow.

I may, however, here call attention to one interesting error in connection with the animal's seasonal variations. Baird and Girard ('53) described *Tricha lævis*, "allied to *T. torosa*, Gray, but smoother, having but slight indications of granulations;" and "Tail very much compressed, with a fringe along the whole upper edge and the posterior half of the lower." The specimens from which this supposed second species was described were collected by Dr. John L. LeConte, at San Francisco, in February, 1850 (Baird and Girard ['53], p. 300). As will be apparent from the account which follows of the animal's changes with the seasons of the year, had Dr. LeConte collected his specimens in mid-summer instead of midwinter, Baird and Girard would have had no *T. lævis*.

Girard ('58) speaks of *lævis* as having been "collected and recorded" by Dr. LeConte under this name, thus seeming to infer that it was Dr. LeConte who first distinguished a second species. He further states that *lævis* is distinguished from *torosa* by being "perfectly smooth," and also by its having "proportionally smaller eyes and more elongated toes." If there is an apparent difference in the size of the eyes of the two forms, it is probably due to the puffy condition of the bodies of the smooth winter forms. This may cause the eyes to seem, relatively to the size of the rest of the animal, smaller than in the "granulated" forms. I have not, however, observed such a difference. Concerning the supposed more slender toes of "*lævis*," I

can only say that I am unable to detect such a distinction. In fact, the reverse is more nearly true; i. e., the toes of "*lævis*" are, in proportion to their thickness, less elongated.

The most complete and accurate description that we have of the species, particularly of its seasonal variations, is by Cope ('89). To this author's work I shall refer several times later on. Brief references, unimportant from any but a classificatory point of view, have been made to the species by Baird ('47-'50), Skilton, and Boulenger ('82).

## II.—THE ADULT.

GENERAL.—It would be superfluous to give here a general description of the animal, since those by Eschscholtz, and by Girard, and particularly that by Cope, are quite adequate, and the last mentioned is readily accessible to most zoologists. As concerns the adults, therefore, I have only to deal with those special points, knowledge relating to which could be obtained only by continuous observation of the animals, living and dead, in large numbers, both in confinement and in their native haunts, and at all seasons of the year.

I do not use the term adult as meaning full-grown, but I speak of the animal as adult as soon as its metamorphosis is complete. Gage ('91) applies the word only to the olive-green, or viridescent form of *Diemyctylus viridescens*; but since there does not exist, as we shall see later, so trenchant a division of the life of our species into two periods as is the case in *D. viridescens*, and since I do not know definitely about the limit of the period of growth, I see no satisfactory way of using the term here excepting that indicated. How long the animal lives, whether or not it grows during its whole life, and at what age it becomes sexually mature, are questions which I am as yet able to answer only partially.

The average length of nine specimens just metamorphosed I found to be 48 mm. The largest one of this age that I

have seen (not included in the nine above mentioned) was 60 mm. long. As a very large number of old larvæ and young adults have come under my observation, I think it safe to assume that the 60 mm. one is about the maximum size attained by the larvæ; in other words about the maximum attained during the first three-quarters of a year of their lives; i. e., from March to October inclusive, which may be taken as the average larval period. The next larger size that I have found in the fall have had a length of about 80 mm. I therefore conclude that these specimens are in their second year—are about one year and eight months old.

As I have never seen specimens of this size in which the external sexual characters were developed, I conclude further that sexual maturity is not reached till after the second year. How much after I have no satisfactory means of judging; but comparing the smallest sexually active males observed with the specimens supposed to be approaching two years of age, I think it probable that the males ordinarily become capable of doing their part in the propagation of the species when they are three years old.

The points of chief importance in the section now under treatment are: (1) those relating to the habits of life; (2) those relating to seasonal changes in structure; and (3) those relating to secondary sexual differences. Of course it will be neither desirable nor possible to keep these distinct in description and discussion.

1. HABITS.—The first point concerning the habits of the adults to which I would direct attention is the fact that the *most strictly terrestrial period of life is that immediately following metamorphosis.*

In view of the notably aquatic habit of the animals for a considerable portion of their adult lives, it has been surprising to me to find that they are exceedingly particular about getting out of the water as soon as the metamorphosis is complete. In fact, if they are so situated that they cannot get out by the time their larval characters, the gill-stubs excepted, are gone; or if after they have once left the water they are immediately put into it again and are not

permitted to escape, they die, apparently of drowning, in the course of a few hours.

I have tested this many times and in both ways; i. e., by arranging an aquarium so that transforming larvæ could not get out of the water at all, and also by putting into such aquaria recently transformed individuals found on land; and the results have been invariably the same. Particularly those captured on land and put into water seem to drown, for, if placed in an aquarium over night for example, in the morning they are found dead, their mouths open and bodies much enlarged. They appear to have imbibed water over the entire surface of the body.

Furthermore, I have frequently noticed that strictly land-dwelling individuals of larger size, as they are often found late in the summer, seem to have a genuine aversion to water. As an illustration of this, one day in the early fall of last year while searching through one of our cañons from which the water had disappeared excepting for an occasional shallow pool, I found many specimens of medium sized adults, all with skins at the extreme of papillation, and tails as nearly finless and round as they ever become. Although water was easily accessible to them all, not a single individual of the dozens seen, as I remember, was in it. In one instance a specimen in making an unusual effort to escape me ran close along the side of a pool where the rocks in his course became so sheer as to make it more and more difficult for him to cling to them, and letting go meant an inevitable fall into the water. Against this the animal struggled with great desperation, and when at last the catastrophe came, no drowning human being ever made more frantic efforts to escape than did this unfortunate "water dog." It could hardly have been fear of the fall that made him cling so tenaciously to the rocks, for ordinarily the creatures are quite heedless of a tumble from much greater heights than this.

Instances of the apparent dread of water by specimens of this size, form, and habit, one sees frequently. The contrast between this and the most complete aquatic habit

is striking indeed. I am convinced that the full-grown males remain in the water during the winter and spring for months together, without ever once leaving it. This I conclude, chiefly from constant observations throughout the year on the inhabitants of the Alameda Water Company's reservoir at North Berkeley.

The animals live here literally in thousands, and consequently a most excellent opportunity is afforded for studying them in nature. Not only do they not leave the water during long periods of time, but they are capable of remaining for considerable intervals beneath it.

I have watched several specimens get along at least for half an hour without coming to the surface; and one individual remained at the bottom of a shallow pool in Strawberry Creek a full hour after I began to watch him before he came up "to blow."

(a) *Respiration*.—There can be little doubt, I think, that pharyngeal respiration takes place here as Gage has shown to be the case in *D. viridescens* and various other Amphibia.

The movements of the pharyngeal parts are apparently less conspicuous in *torosus* than in *viridescens*, but they are none the less certain and constant.

The whole floor of the mouth within the boundary of the lower jaw, and of the neck, is very gradually depressed for a few seconds, then with a sudden twitch, accompanied by a slight but instantaneous opening of the mouth, the depressed parts are contracted, and the water which was taken in—through the nostrils?—during the depression is forced out. The depression of the floor is ordinarily so slight that it may easily be overlooked. If, however, one is able to watch the animal attentively for some time directly from the side of the head, he will see distinctly enough both the downward and the upward movements of the parts. That water is expelled from the mouth when the twitch occurs may be ascertained by carefully watching any fine particles of solid matter, such as powdered carmine, that may be suspended in the water in the immediate vicinity of the mouth. The jet, or current of expelled water, is not directed

straight forward in a line with the oral commissure, but is projected ventralward, almost at an angle of  $90^{\circ}$  with the commissure. This is caused by the vertical wall formed by the premaxillary and maxillary bones which border the mouth cavity from above, and by the fact that when the water is forced out, the mouth is opened so slightly that the entire outgoing current is brought against this wall and consequently is deflected downward by it.

The frequency of the respiratory movements varies somewhat, as would be expected, with the condition and temperature of the water. Under ordinary circumstances one counts on an average about ten expulsions of water per minute.

Apparently the animal does not usually come to the surface of the water to get air, but to expel gas from its mouth. When, under natural conditions, the need of discharging gas is felt by the creature, it makes a sudden start for the surface of the water, frequently swimming almost directly upward. On the instant that the surface is touched by the end of the snout, one or a few small bubbles of gas are discharged from the mouth with a slight popping noise, and the animal turns with a quickness quite in contrast to the rather deliberate movements with which he executes the rest of the process and swims back toward the bottom, frequently taking as direct a course as that by which he reached the surface. The head is not usually thrust out of the water at all, and almost the only visible indication on the surface of what has taken place is the small bubble which is formed and floats away for a short distance before it bursts. It is these facts, viz., the nature of the contact of the snout with the surface of the water, the discharge of the bubble of gas, and the instantaneousness of the operation, that lead me to believe no air is taken in.

I am well aware that this conclusion does not harmonize with that reached by Wilder ('76 and '77), Gage and Gage ('86), and Mark ('90), from their experimental studies on the respiration of *Amia* and *Lepidosteus*, soft-shelled turtles (*Amyda mutica* and *Aspidonectes spirifer*), and *Lepidos*



*teus osseus*, respectively, and I confess that it is not obvious why it should be necessary to go to the surface merely for the purpose of getting rid of gas, presumably carbondioxide, particularly since this gas is so readily soluble in water; and I confess, also, that it is perfectly comprehensible why it would be helpful to respiration for the animal to take in atmospheric air occasionally, even though it depended largely for its supply of oxygen on taking it from the water by means of its pharyngeal movements. There is no doubt that animals confined for a considerable time in a small quantity of water do take air frequently, but their method of doing this is quite different from the process described above. A large part of the head is raised above the surface of the water, the mouth is opened to a considerable width, and a good quantity of air is gulped down. But I have very rarely seen this done by animals in their native waters, whereas the other operation may be witnessed as many times as an observer might desire, where the animals are as numerous as they usually are in the reservoir of which I have previously spoken. But of course the various questions here raised concerning respiration can only be settled by experiment and chemical examination.

Gage ('90 and '91) has shown that in *D. viridescens* the oral epithelium is columnar and ciliated while the animals are strictly land-living, but is pavemented and non-ciliated during aquatic life; i. e., during the larval, branchiate period, and when the aquatic habit is reverted to in later life by the adults.

While in general my observations on *D. torosus* confirm Gage's results, I find some striking exceptions.

On March 9th last, I examined the oral epithelium of eleven large, smooth-skinned, wide-tailed males from the reservoir, all of which I suppose had lived constantly in the water for six months at least. At any rate, there was nothing wanting in them of the characteristics that distinguish the fully aquatic forms to lead me to suppose that some of them had been water dwellers for a longer time than had the others. In two of them, however, I found columnar cells

and cilia in abundance. All the others were without either.

Again, the specimen which I have already mentioned as having remained under water an hour after I began watching him before he came to the surface, I found to possess an abundantly ciliated oral epithelium. This case seems to be in striking opposition to Gage's conclusion that "in all forms of Amphibia and in all stages after the complete disappearance of food yolk, ciliated epithelium is absent from the mouth when the respiration is mostly aquatic, and water is frequently taken into the mouth" (Gage, '90). But I must say that since this specimen's skin was fully papillated and its tail-fin was much reduced, I should not have considered it to be strictly aquatic had it been brought to me without information as to where it was captured. Having, however, seen it remain at the bottom of the stream for so long a time, and having convinced myself by careful observation that it was regularly carrying on the pharyngeal respiration, I can see no sufficient grounds for supposing that it had been anything else than a water dweller for six months or more, at least, i. e., during the whole winter, spring, and summer thus far, viz., to June 29th, the time of writing. And this is the more probable from the fact that the animals do undoubtedly return from the smooth to the papillated condition without leaving the water. I speak of this more fully elsewhere.

I have also found the mouth epithelium ciliated in several females which I have no reason for supposing less aquatic than several others in which such cilia were not present. But it must be borne in mind that absolute certainty, either as to how long or how constantly particular animals have been in water, is possible only upon direct observation, or from having kept them under conditions that would preclude the possibility of their leaving the water.

I find, after having examined a large number of cases, no exception to Gage's conclusion, "that in forms with mostly aerial respiration, when water is rarely taken into the mouth, the mouth is lined with a ciliated epithelium."

I think it highly probable that cutaneous respiration takes place to a considerable extent in animals that have lived long in water. This seems particularly probable as regards those in the extremely smooth, soft-skinned condition which characterizes many males during the late winter. In this state the epidermis is found, when examined in section, to be almost entirely devoid of the external layers of flattened, cornified cells which distinguish the epidermis in its hard, papillated condition.

It becomes, as one might say, stratum mucosum in its entire thickness. This undoubtedly renders it more permeable to gases. The subepithelial connective tissue also becomes markedly augmented in thickness at the same time, and what is of more importance still, a striking increase in vascularity occurs, at least in many cases.

I hope at some future time to study the question of cutaneous respiration in these animals.

(*b*) *Sloughing*.—The little that need be said on this subject may be inserted here. There is, so far as I have been able to determine, no particular season of the year at which this occurs. It frequently happens that the outer layer of the epiderm, the layer which alone is shed, is thrown off, in whole or in part, in large or small pieces, almost immediately after animals are captured and placed in the aquarium. This is particularly likely to occur if the quantity of water in which they are confined be small. One often finds the skin from the limbs quite entire floating in the water; also that from the tail; but from the trunk and head it usually comes off in fragments.

Land-dwelling individuals are not infrequently seen with numerous fragments of dry epidermis clinging to various parts of their bodies. These animals have a very tattered, forlorn look. As soon, however, as the old rags are fully gotten rid of a much brighter, sleeker mien is presented.

The sloughed epidermis is an important article of diet for the animals.

(*c*) *Food*.—Like many other long-tailed amphibians this species is far from fastidious. It eats almost anything, almost

everything, or almost nothing, according to the conditions. As already mentioned, its own cast off epidermis is not rejected as having fulfilled its whole usefulness merely because it can no longer serve as wearing apparel, but it is utilized as food without hesitation. I have found large quantities of it in the animals' stomachs. But the eating of their own skins is not the only way in which they put in practice the doctrine that home products should be consumed as largely as possible. During the breeding period their own eggs and young form an important food staple, particularly, as it seems, for the old males. One often sees one of these fellows taxing his ingenuity and mouth capacity to the uttermost in an effort to get a large egg mass whole into his stomach; and his efforts are frequently successful. I have also seen such males pulling to pieces the jelly of bunches in which the embryos were well developed, apparently for the purpose of extracting the little ones; I must, however, admit that I have never found young larvæ freed from the jelly in the stomach of an adult.

Small snails and slugs, both larvæ and adults of numerous species of insects, sow bugs, earth worms, etc., will generally be found in greater or less quantity when an inventory is taken of the contents of a stomach. But although the animals eat heartily when an abundance of food is at hand, and are not very particular as to the kind of food, they cannot, I think, be regarded as particularly voracious. They certainly can endure for months together with very little to eat, and they never, so far as I see, show by their actions any signs of hunger.

(d) *Movements*.—In their movements, whether on land or in water, they are very deliberate and clumsy, even for long-tailed amphibians. On occasion they can, particularly in swimming, push themselves along with considerable alacrity; but they are incapable of the almost lightning-like movements frequently executed by some other salamanders.

They may almost always be easily captured with the hand. They show little signs of fright, or inclination to flee from a human being. Sometimes, however, apparently

when the conditions are such that one's foot-falls produce a slight jar, either to the water itself or to the bottom on which the creatures may be resting, they will swim or run away for a short distance as one approaches them.

From various tests and observations I do not believe that the sense of sight is of much use to them in distinguishing objects, excepting for short distances—not much beyond a foot it appears—for objects the size of a man's hat.

They are in no sense given to hiding themselves from the light of day. During their aquatic career it seems to be their chief care to dwell in still waters. Nowhere have I seen them in any such abundance as in the reservoir already mentioned; and this lies out perfectly free to the full light of day, and there is almost nothing in or about the water that can be used as a hiding place or a screen from the daylight. It seems hardly possible that they are induced hither by a particular abundance of food, since great care is taken by the water company to keep the reservoir as free from life of all kinds as possible. I may mention that the "water dogs" are taken out in great numbers, as I am told by the Italian workman who lives at the reservoir as an employee of the company, and buried in the ground to prevent their getting back to the water, the fear being, of course, that they are in some way injurious to the water. As a matter of fact, however, their presence is rather an advantage, since they undoubtedly act as scavengers for the water, so far as animal life is concerned.

When living on land they often make long excursions out into open areas; e. g., they are familiar objects to everybody about the University of California, so frequently are they seen slowly and silently strolling about the grounds and over the sidewalks. At such times they do not manifest the least inclination to escape being captured; indeed, I have sometimes imagined them to be presenting themselves as museum or laboratory offerings.

2. SEASONAL CHANGES.—As a considerable part of the interest attached to the results of my studies on the seasonal characteristics of our *Diemyctylus* consists in the compar-

ison made possible between it and its eastern relative, I cannot do better than to carry the comparison along as I proceed with the narration of my observations. To this end it will be best to quote at the outset Gage's summary of his own studies on *D. viridescens*. His paragraphs that will concern us here are as follows:—

“4. After the gills are absorbed the animal leaves the water, and the color gradually changes from an olive-green to brownish-red, and finally, during the same season, assumes a bright yellowish-red, the vermillion spots remaining and becoming partly surrounded by black pigment.”

“6. In the autumn of the third, or the spring of the fourth year after hatching (when two and one-half or three years old), the red changes for a viridescent coloration. This may occur with or without entering the water. If the water is entered the animal changes to an aquatic mode of life.”

“8. After becoming adult and transforming to the viridescent coloration, the *Diemyctylus* always remains of that general color, and never again becomes red, even when kept out of water a whole year, thus showing that the coloration is dependent neither on food, season, nor environment, but is normal for a given period of life only.”

“9. The adult viridescent forms are purely aquatic under favorable conditions, and after once entering the water do not leave it, although they are able to live for several months, and perhaps indefinitely, in moist places, wholly out of water.”

The changes of form and color in our species which take place during metamorphosis from the larval state, I give in detail in my description of the larva. On that point I need consequently do no more here than refer to figs. 4, 5, 6 and 7.

I have already shown that immediately after metamorphosis the adults are more strictly aërial than at any other period in their lives, and that at this time they possess the tuberculated skin and narrow tail in the fullest degree. I have also given reasons for believing that the males, at least,

usually arrive at sexual maturity when three years old. Sexual maturity in the males is not reached, so far as I know, until the aquatic habit is assumed for the second time, and the tail has again become much expanded and laterally compressed. A change of color is, however, not essential to the arrival at this state. We are not, therefore, it appears to me, justified in speaking of a second transformation in this species as Gage does in *D. viridescens*. The difference between a young adult male and a sexually mature one is certainly considerable, but it is very much less than that between the gill-breathing larva and the adult. Furthermore, the transition to the mature condition is much more gradual than is the true metamorphosis. But what is most important of all, and what constitutes the greatest distinction between the two species, is the fact that, according to Gage, the viridescent, or adult form of the eastern species, having been once assumed, the red form is never again reverted to; our species, on the other hand, may certainly go back from the condition which seems to correspond to the viridescent, or adult form of the eastern species, to that which apparently corresponds to the red, or immature adult stage of that species. The characteristics of the two conditions in our species will be readily understood by an examination of figs. 1, 2 and 3.

Figure 3 represents a full-grown male, as these are frequently found in autumn, crawling about on land, quite remote from any water.

Figure 2 represents another of about the same size, taken from the reservoir at North Berkeley, on the first of January, 1896; i. e., during the height of the season's amours. (I point out elsewhere that the males lead the way by some weeks in love-making, so that egg-laying does not begin for some time after the males are abundantly prepared for the occasion.)

In addition to the great width of tail and strength of limbs of the latter as compared with the former, which conditions come out with ample distinctness in the figures, there is in reality a difference almost as striking and characteristic in

the structure of the skin, although this does not appear quite as clearly in the figures.

I refer, of course, to the papillation and the greater hardness of the epidermis of the land-dwelling form. The "granulation" of the skin, as it has been usually designated, pertains, when the condition is at the height of its development, to almost the entire surface of the animal. It is, however, most pronounced on the back and part way down on the sides of the body. In these regions the papillæ are both larger and nearer together than elsewhere. They are least developed about the end of the nose, on the tail, particularly along its ventral side, on the inner surface of the limbs, and on the soles of the hands and feet. They are also always considerably less numerous and lower on the belly than on the back.

Each papilla is crowned by a cap of deeply pigmented cells, in the middle of which is the opening of a gland. Figure 13 represents a surface view of a small piece of sloughed epiderm. It is not my intention to enter into a histological description of the epidermis at present, but I may say that there can be no doubt about the presence of openings at the summits of the papillæ. Even a superficial examination of microtomic sections of the skin is sufficient to convince one of the fact.

The papillæ make their appearance in all individuals, males as well as females, some time before metamorphosis is complete. The *females retain them throughout life*, so far as I am able to determine, while they disappear almost entirely, in many cases absolutely, from males when the aquatic habit is fully resumed. My belief is, though the proof of this is not complete, that in general the papillæ disappear more and more as the animals grow older.

In many specimens, a good example of which is presented by fig. 2, while the epidermis is perfectly smooth, i. e., is wholly without the papillæ, there are frequently seen a great number of light colored spots corresponding in size and distribution with the papillæ when these are present. They are evidently remnants of the papillæ. In still



another condition, an instance of which is illustrated by fig. 1, absolutely no trace of papillæ is to be found. From the comparative rarity and large size of specimens of this kind, I conjecture that these individuals have arrived at about the extreme age to which the species attains.

I must also call attention to the faded out appearance of the two last mentioned specimens. It looks very much as though they were actually sun-bleached. Individuals of this color are by no means rare. In fact, specimens are frequently seen which are more conspicuously light colored as they are seen in the water than those here figured appear to be. Prof. Cope mentions that "in the rough specimens the brown becomes almost black;" and that "in smooth specimens the brown is pale, and has an olive tinge." In general this is true, but it is by no means always the case that the rough ones are almost black. As much as can be said is that the darkest color ever attained is by the rough ones, and that the lightest color reached is by the smooth ones. This color variation takes place in the males alone, the females retaining with considerable constancy their characteristic seal brown color.

The decidedly dark color of the side of the body, as compared with other parts, shown in fig. 2, will be noticed. This condition heightens the impression above mentioned, that the light color is due to sun bleaching—and I may say that specimens of this kind have been seen more frequently than elsewhere in the North Berkeley reservoir, which, as already said, is fully exposed to the sun.

I have previously stated that the papillated, narrow-tailed condition may be again assumed by the smooth-skinned, broad-tailed specimens. Of this I have positive evidence from experiments with animals kept in confinement. Last winter I placed some two dozen specimens, most of which were males with well developed tails and much reduced papillæ, in a terrarium in the laboratory. The most of them are still living (July 3), but they are now all like the one shown in fig. 2. The tails are reduced to the minimum in

depth, and the epidermis is nearly at the maximum of papillation; and I am convinced by numerous observations on animals in nature, particularly by those made during the present spring and summer, that the same reversion takes place normally. I have recently (in midsummer) examined many males, not only at the reservoir but also from several streams in the vicinity, and have not found one which possesses the smooth skin.

Not only this, but it can actually be seen that the papillæ are growing out on skins that were previously smooth. The black tips, at first projecting but slightly above the surface, make their appearance while the general groundwork still shows the smoothness and softness which characterize it when the papillæ are wholly absent. The feel to the hand of the condition here described is quite different from what it is at any other period during the animal's life.

It will be remembered that Gage's conclusion concerning *D. viridescens* is "that the coloration is dependent neither on food, season, nor environment, but is normal for a given period of life only," since he found that the red coloration changes to the viridescent whether the animal enters the water or not, and that it is not resumed even though viridescent specimens are kept out of water for long periods of time. Professor Gage appears to be particular to limit his denial of the potency of environmental change in this case to its influence on color. What he thinks about the cause of the change in the form of the tail, for example, which accompanies the change of color, he does not tell us. Concerning the replacement of a ciliated by a non-ciliated oral epithelium, as the animals change from the ærial to the aquatic mode of respiration, he remarks, however, that "the change has something the character and certainty of a simple chemical reaction."

As regards *D. torosus*, the facts above pointed out, viz., that the repapillation of the skin and reduction of the tail take place even though the animals do not leave the water, might seem to indicate that even *structural* changes in this species are "normal for a given period of life," and are not

dependent on "food, season, nor environment." But I have seen nothing to indicate that the wide-tailed, smooth-skinned condition of the males is ever assumed without the adoption of the aquatic mode of life; and so obviously and perfectly is it an adaptation to such a life that one can scarcely believe it to have been produced by any other cause.

To say that the characters distinguishing it are "secondary sexual characters," and so dismiss the subject with the supposition that an explanation of the facts has been given, is wholly unsatisfactory, even though the males alone present these characters, and that at the time of sexual activity.

It appears to me that instead of regarding the seasonal changes as independent of environment, or as having been produced in response to the needs of the reproductive function, we should come nearer to a satisfying explanation by supposing that *originally* and *immediately* they were caused by change in the mode of life of the animals; and that *now* the characters have become so thoroughly established by heredity that they have acquired a considerable degree of independence of the causes which produced them.

It seems probable that the reason why *D. torosus* reverts to the rough-skinned, narrow-tailed state after it has passed a period in the opposite condition, whereas *D. viridescens* never leaves the viridescent, aquatic form after having once assumed it, is to be found in the difference in habitat of the two species. The region inhabited by *viridescens* is not particularly drier at one season of the year than another, and the streams and ponds which the animals make their home are perennial; so that, so far as environment is concerned, there is no reason why they should leave the water when once they have betaken themselves to it and become well established in it. With *torosus* the case is different. Throughout the greater portion of its range very many of the streams and ponds in which it lives during the winter and early summer dry up *almost* entirely (I doubt considerably if the larvæ ever come to metamorphosis in streams that wholly disappear during the summer); and as a consequence the animals find it to their advantage, in

their search after food, to spend much of this period on land.

It would, I believe, be about as easy to establish the proposition that the annual period of sexual activity is determined by life habits primarily induced through environmental influences, of which those pertaining to food and moisture are probably most important, as it would to establish the opposite proposition; viz., that the life habits and their accompanying structural characters are secondary to sexual activity. But this is a very difficult problem, though perhaps not wholly unsolvable.

3. **SEXUAL DIFFERENCES.**—The characters distinctive of the sexes have been mostly adverted to already, though indirectly.

Until sexual maturity is reached there is, so far as I have determined, no way of distinguishing them by superficial inspection. Males and females are alike papillated and narrow-tailed.

As already pointed out, the females never leave this condition. Whether this is due to a failure on their part to take on the broad tail and smooth skin, because these are in reality male characters, or to the fact that they are less aquatic in their tastes and habits, or to some other cause, I do not know. My observations do, however, lead me to believe that on the whole the males are more fond of the water than are the females.

The great development of the lips of the male cloaca as compared with those of the female during the breeding season is very distinctive. In addition to the great enlargement of these parts, there is a dark band extending down from the general dark ground color of the dorsum and sides of the body on the cloaca almost to the ventral edge of the lips (fig. 2). The female cloaca never becomes enlarged to any extent, and is always without the lateral bands.

During the breeding period there is developed on the inner surface of each femur in the males a patch of epidermis harder and more corrugated than in adjacent parts, and

also furnished with a dark, dirty pigment that does not exist here at other times. The glands in this area are peculiar to it also, but whether they are the ordinary epidermal glands modified for the occasion only, or are permanently different from the latter, I do not know. These patches are rather transient and disappear very soon after the culmination of the reproductive activity. As a rule the soles of the hands and feet of the males become black, and the tips of the digits capped with black at this season, but this character is apparently less constant than are the others mentioned. Figure 10 illustrates the several points described. Prof. Cope's unqualified statement that "the epidermis on the extremities of all the digits is horny," is an error, probably induced by the author's having observed the condition here described. Ordinarily the epidermis of the toe tips does not differ from that on other parts of the members, excepting that it is somewhat smoother.

### III.—BREEDING.

1. MATING AND FERTILIZATION.—Gage ('91) states that an autumnal mating, at any rate so far as the male's part in the process is concerned, takes place in *D. viridescens*. Spermatophores, he says, are emitted precisely as in spring, or the proper breeding season. Copulating pairs of *D. torosus* are not infrequently seen in the early fall in the streams and ponds of this locality. Thus last year I observed such a pair as early as September 23d. Instead, however, of there being an autumnal as distinct from a spring mating in this species, we have to say that the season's amours begin thus early in the year, for the process goes on without interruption from its beginning to the termination of the breeding time. But here as in *D. viridescens* it is an affair of the males alone. Sperm masses are discharged but there are no ova for them to fertilize till some months later, as we shall see further on. Gage is at a loss to understand the significance of the autumnal mating in *D. viridescens*. From what has been said

about *D. torosus* it appears that the autumnal pairing here means merely that the males lead the way by some months in the yearly amours—their sexual products mature earlier by this length of time than do those of the females. If we might suppose that *D. viridescens* or its immediate ancestors once lived in a climate something like that now prevailing in California, where the winters were not sufficiently rigorous to materially retard their physiological processes, we might then suppose that its autumnal mating was likewise the leading of the way by some months of the males in the sexual activity of the year. Then with a change in climatic conditions, either by a migration of the species or by an actual change of climate, the severe cold of winter intervened between the time when the males began their amours and that at which the females were ready to co-operate with them in the reproductive act. Still, from old habit the males began their amorous advances as before; but by the severity of the cold to which they later became subject, they suffered a check in their activities till warmth returned with the following spring; and such an order of procedure as we now see in the species resulted. But in this connection it is important to bear in mind that in some species of urodelos Amphibians, i. e., *Salamandra maculosa*, Knauer ('78) and Pfitzner ('80), the same females reproduce regularly twice a year, in spring and in autumn.

That internal fertilization occurs in this species, as has now been amply proved to be the case in numerous other Urodela, there can be no doubt, since females kept in the laboratory isolated from the males have frequently deposited eggs, and these have always developed in all respects like those deposited under natural conditions in the streams and ponds. Unfortunately my observations on this point are incomplete. The animals appear adverse to carrying on their amours in captivity; at least they have thus far not gratified my desire to have them do so. My information is consequently limited to what I have seen them doing in their natural haunts.

While, therefore, I have not been able to determine with

certainly all the details of the method of fertilization, I still believe *that the sperm by some means reaches and enters the cloaca of the female during the act of copulation*. I would not, however, be understood to mean by copulation that an actual uniting of the external reproductive parts of the two sexes is an essential element in it. I simply mean by it the grasping and holding of the female by the male. My reasons for believing this are chiefly two: First, although nothing is more common during the breeding season than to find the females held in the grasp of the males, I have watched for a great deal, but have never seen a suggestion of such processes as are gone through in several other species; e. g., in *Axolotl* (Gasco '81 and Zeller '90), *Triton* (Gasco '80, Zeller '90 and '91), or *D. viridescens* (Jordan '91 and Gage '91). In all these cases fertilization consists in a preliminary love-making, during which the male discharges one or more spermatophores, not while he holds the female in his embrace (in *Axolotl* this phase of the proceeding is apparently omitted entirely), but free upon the floor of the aquarium, where it is afterwards picked up by the cloaca of the female. My second reason for believing fertilization to be more direct than this in our species is the fact that I have captured one copulating pair in which a large quantity of sperm was contained in and protruding from the cloaca of the female. This case might seem to be conclusive on the point, though of course it is not wholly so, for in the first place the actual passage of the sperm mass from the male to the female was not observed, and in the second place it is quite conceivable that this passage may have taken place by some means less direct than that supposed; or again it is by no means impossible that the sperm mass might have been obtained by the female from some other male than the one with which she was found mating. But, on the whole, when all the facts observed are considered, it seems to me that the belief above expressed is warranted,

The lips of the male cloaca become enormously tumid and enlarged at the height of sexual activity (fig. 2), and during copulation these are made to straddle the dorsum of

the base of the tail of the female very nearly over her cloaca. In several instances, a notable one being that mentioned above, where a large quantity of sperm was found in the cloaca of the female, these lips have been so much extended as to reach fully half way down across the tail of the female. One is reminded of a saddle on a horse's back. At such times the rugæ on the inner surface of the lips (fig. 10) are very prominent. They project beyond the edge of the lips all around the cloaca in the form of a fringe, and are quite conspicuous in contrast with the dark color of the outer skin, they being a lively pink, owing to their great vascularity.

Whether or not this condition may be in some way connected with the transference of the sperm to the female cloaca, I am unable to say; but it seems very possible. And this conjecture is supported by what has been observed concerning the nature of the sperm masses.

From my present knowledge these would be more properly called drops of semen than spermatophores.

I have seen masses of this kind on three occasions: one was deposited on the floor of the aquarium by a captive male; another was taken from the cloaca of a male; and the third was taken from the cloaca of the copulating female already spoken of.

The structure and appearance in each instance were the same. They were semifluid, and hence without definite form, and were semitransparent, though not uniform in color throughout, they being more opaque and somewhat whiter in some parts than in others. Microscopic examination in each case discovered the spermatozoa to be present in great numbers, and in full life and activity.

The spermatophores of *D. viridescens* are described by Gage ('91) and Jordan ('91) as being composed of three parts: a gelatinous part which serves as a base by which the whole is attached to the bottom of the aquarium; a spinous portion projecting upwards from this base; and a spherical mass of spermatozoa clinging to the summit of



this spine. According to Zeller ('90) the spermatophore of *Triton* is even more complicated than this.

Of course my observations cannot be taken as conclusive but from the facts at hand it hardly seems possible that there can be any such highly organized structure in the species now under consideration.

Another circumstance connected with the copulation may be confirmatory of my provisional conclusion about the method of impregnation. In ponds and in quiet places in streams where the water is of considerable depth, mating pairs are almost always seen swimming about, if not at the surface of the water, at least not far below it. I have many times watched these pairs for a considerable period, and it does not appear that they are merely coming to the surface for air or are in transit from one resting place to another, but that it is their custom to swim about while copulating. For the most part the male does the work in swimming, the female remaining quite passive and allowing herself to be carried by her mate; occasionally, however, I have observed the "weaker sex" to "lend a helping hand," or rather a helping tail, in the labor. One is led to wonder if the increase in the width of the tail of the male during the breeding season is not for the purpose of increasing its efficiency as a swimming organ, and of thereby enabling him the easier to carry about his mate while copulating.

Of course if the swimming is continued throughout the entire process of fertilization, the sperm mass must reach its destination by some means more direct than that by which the same thing is accomplished in other species.

I do not wish to be understood to mean that copulating pairs never rest on the bottom; they certainly do, particularly when in shallow running water.

The males of this species are frequently seen carrying on what appears to be quite vigorous contests for the possession of the females.

This I have seen particularly frequently in connection with the swimming pairs. A second male approaches one of these pairs and with movements of unusual energy and

quickness for these animals, grapples them, apparently as it happens; sometimes from above, sometimes from below, sometimes from the side, sometimes fore, sometimes aft. He frequently clings with great pertinacity and the three go writhing and squirming through the water, so wound about one another that it is often impossible to tell which male is in original possession and which one is the assaulter. Occasionally a fourth male joins in, and the tangled, confused, rolling and tumbling mass is strongly suggestive of the characteristic sights in a game of football.

After the struggle has gone on for sometime, it not infrequently happens that all at once one of the contending males, as though seized by a sudden reversion of purpose, turns abruptly from the conflict and swims away as fast as he can go. I think it is usually the attacking male that does this, since when once the rightful spouse gets fully established he clings so tightly and securely by his fore limbs around the body of the female that it is a matter of considerable difficulty to dislodge him.

2. EGG-LAYING AND EGGS.—The time at which egg-laying begins varies somewhat from year to year, it being to some extent controlled by the character of the season.

The first eggs seen during the present spring (1896) were found on February 17, in the reservoir already mentioned several times. These had obviously been laid some days before, since by an accident they had been killed, and the bunches were in an advanced state of decomposition. This date marks, however, very nearly the beginning of the period for this year in this locality, since a pretty close lookout had been kept up for them throughout the winter. The present season has been well calculated to urge all animate nature into unusually early activity; and the "water dog" has not failed to respond with the rest. Although I have no definite notes on the point, I am still quite certain that in ordinary winters the eggs are not found before March.

Egg-laying once begun is carried on with considerable rapidity, and is practically concluded in about two months. The eggs are always contained in the transparent gelatinous

envelop so characteristic of amphibian eggs. Usually the gelatin of from ten to twenty-five eggs is run together so as to make practically a common mass.

When first deposited the gelatin is semifluid and very viscid, but after being immersed in the water for a short time it both swells up and hardens; so that ultimately the masses are of considerable size—2 cm. in diameter being about the average—and are quite firm, their consistency becoming considerably greater than that of the firmest fruit jelly.

For several hours after deposition a well defined layer of gelatin immediately surrounding the egg is somewhat less transparent than the rest of the mass. This is seen in fig. 11, representing a bunch in which the clearing and liquefaction of this portion, both of which take place at a later time, was not yet complete. It is of historic interest that Spallanzani supposed this inner capsule to be “nothing else than the amnios full of liquor.”

There is thus seen to be a striking difference between our species of *Diemyctylus* and its relatives, *D. viridescens*, of eastern North America, and the European *Tritons* (for information concerning egg-laying by *T. cristatus* in particular, see Wood ['71] and Brehm ['78]), in the manner of depositing the eggs. It is well known that these species lay their eggs one in a place. It is further given as a characteristic of them that the eggs are more or less secreted and protected by the leaves of water plants among and upon which they are placed. For the egg-laying habits of *D. viridescens* see particularly Jordan ('93) and Gage ('91).

But the difference between the two methods is not in reality very great after all. In *D. torosus* the long, much coiled oviduct becomes filled with ova, always, however, in a single row, before egg-laying begins; and their being deposited in masses is due to the fact that they cling so closely to one another by the viscid jelly that they cannot be readily separated as they leave the cloaca. Of course the remaining of the mother in the same position while a

considerable number are being extruded is an essential condition to the production of the characteristic masses; but I am convinced that it would ordinarily be impossible for her to separate them even were she to move from place to place during the process of their deposition, so closely do they adhere to one another.

Occasionally, however, they are not in contact with one another, and in such cases may be deposited one in a place like those of *D. viridescens* and *Triton*.

Thus, not only have eggs been deposited singly by females kept in confinement, several times during the last three or four years, but recently I have observed the same thing, in one instance at least, in a state of nature.

While at the reservoir, on March 19 last, I noticed several females closely hugging small pebbles at the bottom of the water, and with their bodies contorted and rigid. One of these I was able to secure, and I found that she had deposited a single egg on one side of the pebble. It is possible, to be sure, that others would have been placed there also had she not been disturbed; but there were no others in sight in her cloaca, and from the fact that the bunches are usually deposited as such, practically, I have no doubt that the eggs were here being laid one by one, as they not infrequently are in confinement.

It is interesting to note, in this connection, Jordan's statement that "the eggs [of *D. viridescens*] are laid singly, as a rule, but occasionally two, and rarely three, may be deposited successively in the same nest;" and we have definite knowledge that at least one other long-tailed Amphibian presents a variety of habit quite similar to that here described in its manner of depositing eggs. Hay ('89) says concerning the ova of *Amblystonea microstomum*, that "they are attached singly and in bunches of various sizes to blades of dead grass."

The bunches are preferably attached to sticks that are firmly anchored to the bottom or the bank of the stream or pond; but almost any object, as stones, water weeds, ropes

or chains that may by chance be in the water, posts, etc., are made use of at times.

In streams, quiet pools and places overhung by the banks are usually selected for the eggs, but in the reservoir, which is merely a great basin with sloping sides, and in which but few foreign objects are contained, they are often attached to any weed or stick that may chance to be found, even though these be in shallow water and fully exposed to sight and to the light of day.

In one or two instances I have found bunches of eggs, laid by females kept in the laboratory, that were not attached to anything, but were loose on the bottom of the aquarium.

In laying her eggs the female clasps the stick or other object to which they are to be attached, not so much by encircling it with her hind limbs as by grasping it between her feet. This position enables her to easily lift her cloaca somewhat from the object as the egg mass is being extruded. I have not actually observed her to thus raise herself, but infer that she does so from the fact that as a rule the egg masses do not depart much from the spherical form, and it is difficult to see how this could be so were the cloaca to be held closely pressed to the object to which the eggs are attached throughout the process of their deposition.

The bunches frequently have a low, flat, conical projection on the side opposite, or nearly opposite, the point of attachment. This is shown in fig. 12.

One frequently observes numerous alternating grooves and ridges on the surface of the gelatin, and not infrequently these converge toward the cone. It seems as though the cone is the last portion of the mass to leave the cloaca, and that it is produced by a slight clinging of the gelatin to the cloaca after the egg mass proper has escaped; and for this reason we may speak of the cone as a hilum. The ridges above mentioned are probably the result of pressure of the jelly mass against the walls of the cloaca, although of this I am not fully convinced, since occasionally they are seen to converge toward more than one center on the surface of

the mass. These striæ converging toward the hilum are shown in fig. 12.

The average number of eggs at a laying seems to be about sixty for each female, these being distributed in three or four of the masses. This I conclude from actual count, in several instances, of eggs deposited in the laboratory, and also from numerous cases where about this number and distribution have been observed in streams and ponds so isolated from all others as to make it probable that they were all produced at a laying and by one female.

A single laying extends over about two days, generally. Whether the same individual has more than one period of egg-laying during a season I do not know, but strongly suspect that in some instances, at least, such is the case.

The eggs are, like those of other amphibians, perfectly spherical, and are considerably more highly pigmented on the animal hemisphere than on the other. There is, however, much less pigment present than is the rule with the eggs of this group of animals. In some instances I have noticed but little difference between the two hemispheres as regards pigmentation.

The eggs are about 2.5 mm. in diameter.

They can be extracted from the gelatin with comparative ease, so that in this regard they are favorable for study.

Eggs kept in the laboratory hatch, i. e., the larvæ escape from the gelatin, in about thirty days from the time of their deposition.

Undoubtedly, as with many other animals, the rate of development of the embryo is subject to considerable variation, depending upon the varying temperature of the water in which they are contained. But I have made no observations on this point.

## IV.—THE LARVA.

I. GENERAL DESCRIPTION.—A larva, twice its natural size, three days after its escape from the gelatin, is shown by fig. 9.

The length of this individual was 13 mm. at the time of making the drawing, and this was a good average specimen. The young larvæ are quite transparent excepting for the black pigment which they contain, and the considerable amount of yoke which persists on the ventral side of the body for a considerable time after hatching.

The pigment is mostly disposed in two well defined bands which extend along the dorsum from a little behind the eyes to the extreme tip of the tail. These bands are, corresponding with the greater width of the head than any other portion of the body, considerably farther apart in this region than elsewhere. The tail and the hinder portion of the body are so thin that when the animal is looked down upon from the dorsal side the two pigment bands are scarcely distinguishable from each other. The bands are sometimes perceptibly heavier in their posterior than in their anterior halves. At the time of hatching there is usually scarcely a trace of pigment excepting in the bands. It is but a short time, however, before scattered pigment spots begin to appear all over the dorsum of the head, dorsum and sides of the body, on the tail fin, particularly the dorsal lobe of it, and on the limbs and feet, as soon as these are formed. Microscopical examination shows that generally each of these spots is at the beginning a single, large, much branched cell, closely resembling those found in many young fishes. At first, and for a considerable period, very little or no diffuse pigment is visible. Figs. 6, 7, and 8 illustrate these points.

The gills, three in number on each side, are well developed at the time of hatching, though the secondary filaments are few in number as compared with those of the full-grown larva. At first the three gills are of nearly equal length, the ventral, or anterior one, being slightly shorter than either

of the others, and the dorsal, or posterior, longest of all. Later, however, this discrepancy in relative length of the anterior one becomes much more pronounced.

There are at hatching usually one or two filaments on the anterior gill, and about three or four on the posterior.

The mouth is not yet broken through when the larva escapes from the jelly mass, but the anterior nares are conspicuous pits on the ventral side of the head quite remote from their ultimate terminal position.

The so-called balancers are prominent during the early larval life (fig. 9), but their atrophy begins in a few weeks after hatching, and no trace of them remains by the time the larva has reached its full size.

At their full development blood corpuscles can be seen to enter these structures. This suggests that they may be useful as accessory gills; it is, however, true that the blood stream entering them is much less in volume than that which passes through the gill filaments. I have seen no indication that these appendages are a compensation for the absence of limbs, as they are stated to be in some urodele larvæ (Baird ['51], Clark ['80]), or are used as clinging organs, as is said by Hay ('89) to be the case in *Amblystomea microstomum*. In *D. torosus* they are cylindrical and of uniform diameter from end to end. The epithelial cells at their distal ends are produced at their outer ends into blunt though distinct processes, so that when viewed with a low power of the microscope the end of the balancer reminds one of the tentacles of various hydroids armed with their lasso cells. Hay ('89) mentions the same condition in *Amblystoma microstomum*.

The extreme transparency not only of the gills but also of the entire animal, makes these larvæ especially favorable for studying the movements of the blood, the character of the living blood cells, the development of capillaries, and other points in the circulatory system; but this subject does not come within the scope of the present paper.

As is the general rule with the larvæ of the Urodela, the fore limbs are the first to appear. They are mere buds at



the time of hatching, but they grow rapidly. By the third day (fig. 9) the toes are already indicated. They are nearly complete before the hind limbs appear, but by the time the larva reaches a length of 2 cm. the hind limbs are also fully developed. All the limbs are, however, much slimmer and more delicate, relatively, throughout larval life than they are in the adult.

The tail-fin of the larva is very prominent at all times, particularly its dorsal portion. This latter extends forward on the trunk almost to the head. Its form and extent are shown in fig. 7. This figure represents a larva taken from Strawberry Creek late in the fall. It is somewhat smaller than a majority of the specimens found at this season of the year, but in other respects well illustrates the appearance of the larvæ as they are found in abundance from early autumn till far into the winter. The green tinge of all the parts from which black pigment is absent was slightly more pronounced in the specimen here figured than is the case with all individuals.

2. FOOD AND FEEDING.—The food of the larvæ consists mostly of the minute organisms and decomposing organic matter that collect on stones, sticks, weeds, etc., found in quiet parts of the streams. Their method of feeding may be easily watched, not only in aquarium specimens, but also in those at home, out of doors. From the terminal position of the mouth, the proneness of the body, and the want of a true neck, the animal usually selects some object, from the surface of which he proposes to scrape off his meal, that projects sufficiently above the surface on which he rests to enable him to get along without altering his natural posture. Occasionally, however, when no such elevated object is at hand, and the food is all scattered in a thin layer over the surface on which the animal rests, he exhibits in an interesting way his capability of altering his usual course so as to meet the unusual conditions which he finds imposed upon him. He lifts himself up on his feet, "stands on his tip toes," as it may be truly said, then by as short a downward flexure as possible of his head and

potential neck, he succeeds in bringing his mouth into position to eat from the surface on which he stands, just as a cow or horse does. The operation is ludicrous enough—and equally suggestive. I have seen no evidence either in overt act, or from examination of the stomachs of the animals, that they are characterized in their native haunts by that degree of rapacity that distinguishes the larvæ of some of the urodela, of our *Chondrotus lugubris*, for example. In confinement, however, I have several times seen individuals seize their companions by the feet or gills, evidently with no merely playful intent; and the frequent occurrence of specimens in the streams and ponds with absent or mutilated tails, feet, legs and gills, is rather suspicion-arousing evidence concerning the ethical code that prevails among them. In justice it must be said, however, that our streams are tenanted by other creatures which may be the criminals. A large Cadis fly larva, in particular, armed with powerful mandibles, is common throughout the summer, and one occasionally finds this clinging to some portion of the body of the adult newts (I have never *seen* a larva attacked by them), its mandibles deeply buried in the flesh of its prey.

3. MOVEMENTS.—I have been much interested in the apparent indeterminateness of the movements of the very young larvæ. Unless disturbed in some way the creatures move very little for several days after hatching; when, however, they do swim, they go off with a purposeless, spasmodic flutter that seems more like the movements of some sort of a child's toy animal, which may, by winding up its spring, be made to move in a very particular way, and for a certain number of seconds. After fluttering about for a few moments only the creature drops to the bottom of the aquarium, apparently exhausted—its "spring run down"—and it is quite as likely to fall on one side or the other of the body as to take its normal position. And this tipped over attitude seems to be in no wise uncomfortable, for it may be retained for a long time.

As the larvæ grow older their movements become much

less machinelike; they crawl on the bottom part of the time and swim part of the time; they vary the rate and character of their movements; they occasionally seem to go *somewhere in particular*, as toward a stick or stone on which there is food, or toward an object under which they may secrete themselves.

It is sometimes stated concerning the larvæ of other urodela that they use their limbs as oars, but I do not believe this is ever the case with these. So far as I can determine, their swimming is done entirely by means of the tail. The limbs are of use only in crawling on the bottom and in balancing themselves when suspended in the water.

#### V.—THE METAMORPHOSIS.

I have no evidence that the metamorphoses of the larvæ begin earlier than about the first of September, but from this time on to December and January all stages of the transformation may be seen in abundance, both in the streams and in aquaria specimens. October appears to be the culminating period of the process, since during that month specimens undergoing the change, and the young adults just leaving the water, are found in larger numbers than at any other time.

I am unable to say exactly how much time is required for the metamorphosis. In one instance an individual showing no other signs of transformation than a slight change in color (see below for the order of events during metamorphosis) was taken from a stream and placed in an aquarium on October 12. On the 28th of the same month the change had so far advanced that the animal seemed to want to get out of the water, and it was consequently transferred to a moist terrarium, where it lived and flourished, though the gills did not fully disappear until some days later. Observations noted in several other cases indicate that this is about the usual time for specimens kept in the laboratory. I am, however, much inclined to believe that the process goes on considerably more slowly in some cases, at least in a state

of nature. Undoubtedly conditions of temperature and food largely influence the time required.

Although my observations on the animals in their native haunts are inconclusive on the point, it appears that they may occasionally remain in the larval state for a much longer time than the usual period. This they certainly do in confinement and under conditions not so widely different from those which surround them in nature as to make it seem improbable that the same thing may sometimes occur naturally. At the present moment, June 16, I have three larvæ in an aquarium in the laboratory which have come over from last year's crop, and none of them show any signs of metamorphosis as yet. Two of these eat well and seem to be in a perfectly normal condition.<sup>1</sup>

In the spring of 1888 a friend of mine, Mr. W. Payzant, and myself hatched a large number of embryos in confinement. These all died during the summer excepting a single one, and *this lived—as a larva—until January 18, 1892, nearly four years*. It was then killed in order to make sure of it for study before it should undergo metamorphosis. The total length of this specimen, measured just before being killed, was 40 mm. Although it had not grown perceptibly since it was about one year old, I do not think this was due to lack of food, because its aquarium always contained an abundance of both plant and animal life, and in such balance that the surface of the water was constantly covered with a rich growth of *Lemna*.

The largest larva at metamorphosis that I have measured, and certainly as large as any which I have seen, had a total length of 60 mm. But the size, viz., 40 mm., of our four-year old specimen, was undoubtedly much nearer the average of those that have come under my observation than was the 60 mm. individual above mentioned. The smallest specimen at metamorphosis mentioned in my notes was 30

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<sup>1</sup> October 9, 1896—One of these specimens underwent metamorphosis early in August, and not being permitted to leave the water died on August 10. Another died still in the larval state about the middle of September. The third had died some time before without metamorphosing.

mm. in length. From numerous measurements the average length at metamorphosis appears to be about 47 mm.

The first visible evidence of the impending metamorphosis consists in a very slight duskiess over all the dorsal parts of the animal outside the black bands, and a simultaneous tinging of the ventral surface with the yellow that will characterize this region of the adult.

These color changes become rapidly more pronounced, particularly as regards the dorsal side, where the brownness of the head and neck region is soon especially noticeable. The black bands of the back diminish in distinctness *pari passu* with the increasing general duskiess of this region, until by the time metamorphosis is complete they have disappeared entirely. Figs. 4 and 5.

The general dark color of the transforming larva is due to the presence *in the epidermis*, and for the most part in its outer, or corneous layer, of fine granular, diffuse pigment; while, as previously stated, the characteristic larval pigment is contained in large, usually much branched sub-epidermal, *connective tissue cells*.

The precise histological changes that occur in the integument during metamorphosis I do not enter upon in the present contribution.

The first change of form which takes place consists in the beginning reduction of the dorsal lobe of the tail fin. As already stated, and as shown by fig. 7, this extends almost to the head in the full-fledged larva. It is in its anterior portion that the diminution first becomes noticeable; but soon it is observed to be distinctly lower in the tail region proper; and by the time the animal is ready to leave the water almost all the previously transparent part of the tail, i. e., the whole of the true lobe, ventral as well as dorsal, has quite disappeared, and the tail has become almost round in transverse section (figs. 4 and 5).

The skin, entirely smooth during larval life proper, begins to take on the granular structure characteristic of the summer condition of the adult, almost as soon as the change of color begins; and even before the gills have fully disap-

peared the surface is almost as rough and hard as that of an adult female.

It is a noteworthy fact that the *gills are not the first structures to show indications of metamorphosis, and that they do not fully disappear until after the process is complete in other respects.*

On this point I quote from my notes: "Oct. 12, 1895, captured at Little Lake Chabot a larva 6 cm. long, tail-fin nearly reduced, dorsal skin almost completely papillated, ventral skin yellow, but *gills only slightly reduced*. Very little of the longitudinal dorsal stripes remaining—back nearly uniformly brown."

On October 19 the note made was: "Larval characters all gone *except the gills*. Specimen has not yet come to the surface of the water."

On the 23d the gills were found to be greatly reduced; the stubs had become much more highly pigmented than they previously were, so much so that the circulation in them could be but very imperfectly seen.

The statement in my notes that the larval characters were "all gone" excepting the gills before the animal began to come to the surface of the water, if strictly true for this case would certainly not be so in general, for the usual thing is that they spend considerable time at or near the surface, at least those kept in confinement do, while they yet retain larval characters quite distinctly.

That some larvæ should undergo transformation any way, even though it means destruction to them, while others kept under appreciably the same conditions should for so long a time show no indication of metamorphosis, furnishes a beautiful illustration of the delicacy of balance, but at the same time the intricacy of the forces, which determine the life of an organism.

It also illustrates well what widely divergent results may come from causes with differences so trifling as to escape recognition without the most careful scrutiny, sometimes even with it. My larvæ still living as such and now considerably more than a year old have been kept in essentially

the same kind of an aquarium as to size, shape, relation to light and temperature, quantity and quality of water and of food, as were all the others that underwent metamorphosis in the fall and early winter of last year. If the different results are due to difference in conditions, the differences have been so slight that nothing short of the most exact measurements and observations would detect them. Sometime in the future I hope to subject the matter to rigorous experimentation; but for the present I merely point out that such a course is essential in order that we may know the conditions under which one of the three following fundamental but obviously possible things will happen in the lives of these larvæ: (1) When they will develop into normal adults; i. e., adults capable of perpetuating their kind; (2) when they will remain in the larval condition; i. e., in a condition such that were it to be retained by all the individuals hatched for a few consecutive years the extermination of the species would be the result; or (3) when they will reach reproductive maturity in the larval state, thus originating a possible new species, or even a new genus, of Urodela. Were sexually mature larvæ of this species to continue to live and reproduce in this condition throughout their lives, generation after generation, even if this were demonstrably dependent on external conditions, I suppose most zoologists would no longer regard them as *Diemyctylus torosus* larvæ, but would look upon them as a new species.

With the completion of the metamorphosis, the adult state, in the sense in which I have used the term, is reached, and since our account began with this stage in the animal's life history, we have now returned to our starting point.

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## EXPLANATION OF THE FIGURES.

## PLATE III.

(Figs. all natural size excepting 8, 9 and 13.)

Figs. 1, 2 and 3 represent fully grown males, 1 and 2 being the smooth-skinned, wide-tailed, light-colored, water-dwelling form during the breeding season. The specimen figured in No. 1 was soft and water-soaked. No trace of the papillæ could be seen. The soaked, puffy condition caused the "segmentation" of the trunk to appear with unusual distinctness.

Fig. 4. A young adult, the larval characters all gone excepting the gill-stubs.

Fig. 5. An individual about half metamorphosed.

Figs. 6 and 7 represent the same specimen—a larva somewhat more than half grown.

Fig. 8. A four-year-old larva, twice natural size.

Fig. 9. A larva, twice natural size, three days after leaving the egg-mass.

Fig. 10. The legs and cloaca of a male during the breeding season—to show the black soles, the femoral patches, and the rugæ and papillæ of the cloaca.

Figs. 11 and 12, egg-masses; No. 11 seen as a transparent mass. This mass had been deposited but a few hours. No. 12 seen as an opaque body, showing the hilum, and the striæ converging toward it.

Fig. 13. Small fragment of a flat preparation of the epithelium of a papillated individual, showing the highly pigmented cells at the summits of four papillæ, and the orifices at the centers of three of these.

- 15 1. If the final member is a noun (*a*) of the first declension, with stem ending in *-a-*, or (*b*) of the second declension, with stem ending in *-o-*, or (*c*) of the fourth declension, with stem ending in *-u-*, the compound adjective (A) may  
 16 have the endings *-us*, masc., *-a*, fem., *-um*, neut., or (B) after the analogy of the *-i-* stems, it may appear with the endings *-is*, masc. and fem., *-e*, neut.; as there is nothing by which to decide, we often find both: e. g.

(A)	(B)
(a) im-berb-us (im-, <i>not</i> , +barba, <i>beard</i> ), <i>beardless</i> ,	(a) im-berb-is;
in-fam-us (in-, <i>not</i> , +fama, <i>fame</i> ), <i>infamous</i> ,	in-fam-is;
in-anim-us (in-, <i>not</i> , +anima, <i>life</i> ), <i>lifeless</i> ,	in-anim-is;
se-cur-us (se-, <i>without</i> , +cura, <i>care</i> ), <i>careless</i> ,	
(b) in-anim-us (in-, <i>not</i> , +animus, <i>life</i> ), <i>lifeless</i> ,	(b) in-anim-is;
multi-iug-us (iugum of <i>many yokes</i> ), <i>manifold</i> ,	multi-iug-is;
in-erm-us (pl. arma, <i>arms</i> ), <i>unarmed</i> ,	in-erm-is;
multi-cav-us (cavus, <i>cave</i> ), <i>of many caves</i> , and	ex-somn-is;
(c) quadri-man-us (manus, stem manu-, <i>hand</i> ),	(c) quadri-man-is;
<i>four-handed</i>	
multi-fruct-us (fructus, <i>fruit</i> ), <i>abounding in fruit</i> , but bi-corn-is,	
(bi-two, +cornu, <i>horn</i> ), <i>two-horned</i> ; so angui-corn-is, <i>serpent-horned</i> ; etc.	

- 17 2. If the final member is a noun of the fifth declension, with stem ending in *-e-* (nominative singular in *-es*), the compound adjective ends in *-us*, *-a*, *-um*: e. g.

per-di-us (dies, *day*), *lasting all day*;  
 levi-fid-us (fides, *credit*), *of slight credit*;  
 per-fid-us (fides, *honor*), *treacherous*, but  
 ex-spes (spes, *hope*), *hopeless*.

- 18 3. If the final member is a noun of the third declension, with stem ending in *-i* or in a consonant, the compound adjective will have the form and inflection of its final member: e. g.

multi-fori-s (fori-s, *door*), *many-doored*<sup>1</sup>;  
 semi-cani-s (cani-s, *dog*), *half-dog*;  
 multi-cauli-s (cauli-s, *stalk*), *many-stalked*;  
 tri-dens (dens, dent-is, *tooth*), *three-toothed*;  
 bi-frons (frons, front-is, *brow*), *two-browed*;  
 in-quietes (quietes, quiet-is, *rest*), *restless*;  
 per-nox (nox, noct-is, *night*), *lasting all night*;  
 dis-cors (cors, cord-is, *heart*), *disagreeing*;  
 multi-color (color, color-is, *color*), *many-colored*;  
 bi-pe(d)s (pes, ped-is, *foot*), *biped*;  
 se-grex (grex, greg-is, *flock*), *separate*;  
 multi-radix (radix, radic-is, *root*), *many-rooted*.

19 NOTE.—Compounds of genus have either -genus, -a, -um, or -gener-us, -a, -um, or -gener-is, -e: e. g. multi-genus, -a, -um, or multi-generus, -a, -um, or multi-generis, -e, *of many kinds*.

20 4. If the final member is an adjective, it will suffer no change in entering into composition: e. g. per-magnus, *very great*; multi-potens, *very powerful*; semi-nudus, *half-naked*; semper-vivus, *ever-living*.

21 5. If the final member is a verbal root, it will simply add the case-ending of the adjective—in the nominative either  
 22 (a) -s (subject to the phonetic laws), or (b) -us, -a, -um—directly to the root: e. g.

- (a) parti-cep-s (cap-ere, *take*), *taking part*;  
 morti-fer (fer-re, *bring*), *death-bringing*;  
 sacri-fecs (x) (fac-ere, *make*), *sacrifice-making*;
- (b) magni-fic-us (fac-ere, *make*), *great-making*;  
 perterri-crep-us (crep-ere, *rattle*), *terribly rattling*;  
 male-vol-us (vol-o, *wish*), *ill-wishing*; so bene-vol-us, bene-fic-us, etc.

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<sup>1</sup> The analogy of the *o*-declension has made itself felt here also and we have multi-forus side by side with multi-foris.

The formulæ for making the various classes of adjectives are as follows:

	Prefix		Noun-stem		(Stem-vowel)		Case-ending
23	1.	im-	berb(a)-	i-	s,	<i>beardless</i> ;	
		ve-	san-	u-	s,	<i>mad</i> ;	
		de-	men(t)-		s,	<i>mad</i> ;	
		per-	noc(t)-		s, i. e. per-nox,	<i>lasting all night</i> ;	
		bi-	pe(d)-		s, i. e. bi-pes,	<i>biped</i> ;	
		se-	greg-		s, i. e. se-grex,	<i>separate</i> .	

		Adjective-stem		(Stem-vowel)		Noun-stem		(Stem-vowel)		Case-ending
24	2.	magn(o)-				anim-	u-		s,	<i>magnanimous</i> ;
		miser(o)-	i-			cor(d)			s,	<i>compassionate</i> ;
		mult(o)-	i-			mod-	u-		s,	<i>manifold</i> .

- 25 (a) The NUMERALS, as first member of compounds, deserve especial mention:

(1) unus follows the general rule and appears as uni-: e. g.

uni-color, *having one color*;  
uni-formis, *uniform*.

(2) du-o appears as a prefix in the form of either du-or bi-: e. g.

du-plex, *double*, but bi-pes, *biped*;  
du-plus, *double*, bi-cornis, *two-horned*;  
du-bius, *doubtful*, bi-lobus, *two-lobed*.

(3) tres always appears as prefix tri-<sup>1</sup>: tri-color, *three-colored*; tri-cornis, *three-horned*; tri-fasciatus, *three-striped*, etc.

<sup>1</sup> Except in tre-decim, tre-centi (and their derivatives) and tressis.

(4) quattuor always appears in the form of a prefix, regularly quadri-cornis, *four-horned*; quadri-punctatus, *four-spotted*; quadri-dentatus, *four-toothed*; but influenced by the form and sound of quattuor and quartus, that quadri- may also appear as quadru-: e. g. quadru-manus, as well as quadri-manus, *four-handed*; quadru-pes as well as quadri-pes, *quadru-ped*; etc. Elision will, of course, take place when the second member begins with a vowel: e. g. quadr-angulus, *quadrangle*.

(5) From quinque on, the indeclinable numerals are simply prefixes, suffering no change when they enter into composition, subject, of course, to the usual phonetic laws<sup>1</sup>: e. g. quinque-libris, *five-pound*; sex-punctatus, *six-spotted*; septem-flu-us, *sevenfold-flowing*; octo-punctatus, etc. The declinable numerals of the higher orders are treated like other adjectives, while centum also may follow the same analogy making centi-peda, *hundred-footed*; centi-manus, *hundred-handed*; but also centum-peda; centu-plex; etc.

	Noun-stem	+	(Stem-vowel)	+	Verbal-root	+	(Stem-vowel)	+	Case-ending
26	3.	magn(o)-	i-	fic-	u-	s,	<i>great-making</i> ;		
		fun(i)-		ambul-	u-	s,	<i>rope-walking</i> ;		
		sacr(o)-	i-	fec-		s,	<i>sacrifice-making</i> ;		
		part-	i-	cep-		s,	<i>sharing</i> ;		
		mort-	i-	fer,			<i>death-dealing</i> .		

<sup>1</sup>5. quinque- is the rule; but the rule is not meant to include the compound numerals like quin-decim, quinquaginta, quin-genti, etc., nor strange forms like quincu-plex and quincu-pes, which are obviously formed after the analogy of quadru-plex and quadru-pes.

6. ses-centi, se-mestris and their derivatives, conform to the rule, while se-pes is made after the analogy of se-mestris.

7. Besides septem- we find sometimes septu- and septi-, which arose from analogy with quadru- and quadri-, octu- and octi-; or possibly

		Prefix	Verbal-root	(Stem-vowel)	Case-ending
27	4.	in- se-	iug- cur-	i- u-	s, <i>unyoked</i> ; s, <i>careless</i> .

- 28 5. Verbs are rarely used as first member of a compound; when they are so employed, their stem vowel appears as -i-, either from a natural weakening or from analogy with stems that do suffer such weakening: e. g.

horri-ficus (horre-re, *dread*, + fac-ere, *make*),  
*horror-stirring*;

posci-nummus (posc-ere, *ask*, + num-mus,  
*coin*), *begging*;

terri-ficus (terre-re, *frighten*, fac-ere, *make*),  
*terror-causing*;

perterri-crepus (perterre-re, *terrify*, crep-  
ere, *rattle*), *terribly-rattling*.

- 29 6. Adverbs may be prefixed to almost any adjective without affecting the form: semper-vivus, *ever-living*; bene-volens, *well-wishing*; male-dicens, *evil-speak-ing*; etc.

#### GREEK COMPOUNDS.

The construction of compound words is an art; the consummate mastery of that art is attainable or attained only in the language of Greece. The Germans pile words together in a convenient way and call them compounds, but they are inartistic and artificial. Sanskrit is incomparably richer in compositions than either Greek or German, or both together,

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septu- was influenced by septu-aginta, and septi- is the natural weakening of septu-.

8. octo- is the rule; but when octō became octō, it naturally followed the course of the o- declension and became first octu- and then octi-.

9. novem- and noven- are both in use and both regular; noven is the older form of the word: e. g. noven-dialis, *of nine days*; Novem-ber, *the ninth month*.

but those great mountains of words massed one upon the other—a single word often translatable only by a long, involved sentence—are no more to be compared artistically with the Greek compounds than the hundred-handed Vishnu is to be compared with the Hermes of Praxiteles.

- 30 In forming New Latin compounds of Greek elements there are, just as in the case of Latin compounds, two possibilities: (1) that the word formed will be a noun; (2) that the word formed will be an adjective. Which it will be depends entirely upon the will (and, perhaps, the skill) of the coiner. The rules in either case might be formulated thus:

### I. NOUNS.

- 31 1. We may find the Greek compound already borrowed entire or manufactured by the Romans and take it just as it stands in the Latin lexica. [Most words of that kind available for generic names in Zoology or Botany have already been found and used.]
- 32 2. We may take the compound as it exists in Greek and simply transliterate it into Latin letters.<sup>1</sup>

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33 <sup>1</sup>The accepted transliteration of the Greek letters into Latin is as follows:

$\alpha$ a	$\iota$ i	$\rho$ r ( $\acute{\rho}$ rh; $\rho\rho$ rrh)
$\beta$ b	$\kappa$ c	$\sigma$ s
$\gamma$ g	$\lambda$ l	$\tau$ t
$\delta$ d	$\mu$ m	$\upsilon$ y
$\epsilon$ e	$\nu$ n	$\phi$ ph
$\zeta$ z	$\xi$ x	$\chi$ ch
$\eta$ e	$\omicron$ o	$\psi$ ps
$\theta$ th	$\pi$ p	$\omega$ o

The rough breathing ' is represented by h, the smooth breathing ' is taken for granted and not represented in Latin. Final -ος and -ον, of the second declension, are represented by -us and -um. But final -ως is, of course, rendered by Latin -os. This distinction is an obvious one, and yet the error of transliterating -ως by -us is one into which even the best may fall. For instance, Dr. Gill, in his address before the American Association for the Advancement of Science ("Science," Vol. IV, p. 587), protests against the rule as



- 34      3. We may take simple Greek words and manufacture of them the compound as it would have existed in Greek and then transliterate it into Latin. The manufacture will take place in accordance with the remaining formulæ.
- 35      4. If the final member of a *nomen compositum* is a noun, the compound will have the form and gender and inflectional stem of that noun: e. g.

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just given and says: "In accordance with such rules, *Rhinoceros* has been turned into *Rhinocerus*. But *Rhinoceros* was admitted into classical Latinity, and with it the corresponding oblique cases, *Rhinocerotis*, etc.; in fact, the word was current in the language of description, satire, and proverb—as when used by Juvenal for a vessel made of the horn, or by Lucilius for a long-nosed man, or by Martial in the proverbial expression, '*Nasum rhinocerotis habere*'; i. e., *to turn the nose up*, as we should say. These authorities are good enough for me." Most naturally; for they are true to the law! Dr. Gill is unfortunate in his choice of example. *Rhinoceros* is correct, according to rule, and *Rhinocerus* is wrong; the spelling -us does not occur in any classical author (except in a false reading in Lucilius, where -os is now read). Of course, there can be no question about the existence of forms in -os for Greek -ος and -ον for -ον in a certain class of writers of the Silver Age, when, according to that same Juvenal, Rome was more Greek than Latin. Apuleius occasionally so transliterates; but it is simply one of his many Greek mannerisms. Pliny the Elder is responsible for the most of the transgressions of that law which are to be found in the dictionaries; his reason for such violation of the Latin law is found in his desire to present the technical or scientific words of his Greek original in an untranslated, unchanged form. The same phenomenon, with the same reason underlying, is to be found in the Church Fathers. And so we have, hammo-chrysos, hady-osmos, ophidion, gingidion, and many more; most of them, as I said, are Pliny's Latin, but Pliny's solecisms or mannerisms should not be good enough for any one when a better than Pliny (in point of Latinity, at least) can be found; and the law both before and after Pliny was: Greek -ος is Latin -us, and Greek -ον is Latin -um.

The diphthongs:

αι	æ	αυ	au	υι	yi	η	e
ει	e or i	ευ	eu	α	a	φ	o
οι	œ	ου	u				

ai and oi for αι and οι before another vowel appear only in a few proper names, as *Achaia*, *Troia*, etc., and therefore do not concern us. The strict Latin orthography cannot be too rigorously insisted upon; consistency will in no other way be obtainable.

anthropo-latras, -ae, masc. (-λάτρης, -ου, masc., stem λατρα-), *man-worshiper*;  
 cerco-pithecus, -i, fem. (πίθηκος, -ου, fem.), *a monkey with a tail*;  
 chamaer-ops, -opis, fem. (ᾠψ, ᾠπ-ός, fem.), *the wall-germander*;  
 dia-gramma, -grammatis, neut. (γράμμα, γράμματος, neut.), *diagram*;  
 dasy-pus, -podis, masc. (πούς, ποδός, masc.), *a kind of rabbit*;  
 chamae-cyparissus, -i, fem. (κυπάρισσος, stem κυπαρισσο-, fem.), *cypress*;  
 aego-ceras, -ceratis, neut. (κέρας, stem κερατ-, neut.), *goat's horn*; so also  
 rhync-ops, -opis, fem.; cyclo-stoma, -stomat-  
 matis, neut.; hippo-potamus, etc., etc.

- 36 The gender and stem of the compound are the same as  
 those of its final element; the genitive singular of the com-  
 37 pound is formed in the same way upon that stem; and if  
 patronymics were to be formed from such words, they  
 would be made by adding -idae or -inae to the stem<sup>1</sup>: e. g.  
 anthropo-latridae, chamaer-opidae, dasy-pod-  
 idae, aego-ceratidae, rhynch-opidae, cyclo-  
 stomatidae, etc.

There are a few apparent exceptions to this in our classical lexica, but they are only apparent: e. g. opisthodomus, although derived—borrowed directly—from ὀπισθόδομος, masc., is given (correctly?) as feminine. Δόμος, when transcribed into Latin letters, is identical in form with Latin domus, fem. (which is not derived from

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<sup>1</sup>If the stem ends in a vowel, it will, of course, suffer elision before the suffix -idae. The only other patronymic suffix in Greek is -ίων, but it is of rare occurrence except in proper names: e. g. στρουθ-ίων, *ostrich*; πορφυρ-ίων, *the purple coot*; and a few others.

No regard needs to be paid to the Latin patronymics. The Romans had no patronymic formation of their own, and when they came to borrow from the Greek, their lack of consistency in following their models introduced a chaos, out of which no rules can be deduced for our guidance.

the Greek but a genuine Latin word), and the gender would naturally, in the mouths of the people, be changed by the analogy of the Latin word.

The same danger threatened all the Greek derivatives that became thoroughly Latinized and entered into the language of the people; many succumbed, and yet not so many as one would naturally expect. Twenty-five or thirty will exhaust the list: e. g. the catapult is a Roman rather than a Greek implement of war, and so we are not surprised to find *cata-pulta*, -ae, fem., although it owes its origin to *καταπέλτης*, -ου, masc. *Dia-dema*, *dogma*, *schema*, etc., were looked upon as neuter nouns and inflected

*dia-dema*, -*demat-is*, -*demat-i*,  
*dogma*, *dogmat-is*, *dogmat-i*,  
*schema*, *schemat-is*, *schemat-i*, etc.,

or were considered feminine and inflected

*diadema*, *diademae*,  
*dogma*, *dogmae*,  
*schema*, *schemae*, etc.,

according as they were felt as genuine Latin words or as Greek derivatives. Cicero took pains to show that he thought *dogma* a Greek word by writing it with Greek letters, *δόγμα*. So also we find *oxy-gala*, gen. *oxy-galact-is*, neut., and also *oxy-gala*, -ae, fem., from Greek *ὀξύ-γαλα*, -γάλακτος, neut.; *cata-rrhactes*, -ae, masc., and *cata-rrhacta*, -ae, fem., from Greek *καταρράκτης*, -ου, masc.; etc. In almost every instance of change of gender and inflection, we find, side by side with the Latin change, Latin forms preserving the gender and inflection of the Greek.

- 38 (α) The gender of the genus name, when it is made a noun, depends, therefore, not on the termination, but upon the gender of the noun forming the final element of the compound.

This rule is the only one that can have any philological basis. It is deduced from the practice of the classical

word-makers and from the practice of scientists from Linnæus down: e. g. (the instances cited on p. 129); from Linnæus, *Systema Naturæ*, I<sup>2</sup>: *Didelphis virginiana*, *Rhynchops nigra*, *Ophidion barbatum*, etc. The variations on the part of naturalists from this rule are due either to arbitrariness or misunderstanding: e. g. *Gnathypops rhomaleus*, *Hypsipops rubicundus*, and others of the sort were made in the supposition that ὄψ was a masculine noun; *Hypognathus serenus*, in the idea that γνάθος was masculine; so *Hybopsis hyostomus*, and many more.

- 39 NOTE.—The theory has been advanced and emphasized that all these compound names are adjectives, with a noun understood.<sup>1</sup> That theory, if rigorously insisted upon, will not leave a single compound noun in the whole Greek language. It will hold good in the case of some but not of all, by any means. *Αἰνο-λέων*, *μικρο-πολίτης*, *τρωγλο-δύτης*, *κυνόσ-ουρα*, *προ-κύων*, *λεοντο-πέταλον*, *έρπ-άκανθα*, *Διόσ-κουροι*, *σταφυλό-δενδρον*, *χαμαί-πιτυς*, *πρό-ναος*, *ξιφο-μάχαιρα*, *πιτυνο-κάμπη*, *χην-αλώπηξ*, and any number more are just as good nouns as were ever produced, and the same is true of the names of genera, as both scientists and philolo-

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<sup>1</sup>This theory seems to originate with one Herrmannsen, who is quoted as saying: *Vocabula composita Graecæ originis, quorum terminalis radix generis neutralis, in a exiens, genitivo -ατος flectitur, nonnisi adjectivo sensu adhibentur. Hinc sine neutralia numero plurali obveniunt, ut Adeloderma, Cricostoma [sing. -ιτι, vel -ον], terminentur genitivo -ορι; sin autem singulari numero, ut Amphidesma, Cyclostoma, feminini erunt generis, et declinabimus "Cyclostomæ." Documento sint veterum nomina ὄστραχόδερμα [which is simply neuter plural of the adjective ὄστραχόδερμος, see §§ 44 and 55], τρίστομος, ἄδεσμος.—Quoted by Dr. Gill, *National Academy of Sciences*, Vol. VI, Sixth Memoir, p. 129.*

Herrmannsen's rule is all very well, with the exception of the two words nonnisi adjectivo; the falsity of this assumption is abundantly proved by a host of examples, such as *dia-dema*, genitive *diadematis*; *diaphragma*, genitive, *diaphragmatis*; *epigramma*, genitive, *epigrammatis*; *emblema*, genitive, *emblematis*, etc., etc. See §§ 35-44. The possibility of an adjective formation of the sort assumed by Herrmannsen is recognized in § 44 and more fully explained in § 55.

gists look at them. If we could assume that they were adjectives, it would puzzle one to discover why one *piscis* is feminine, another masculine and a third neuter. It is the same with *aves*, *reptilia*, *plantae*, etc.; and the word chosen for the assumed adjectives to agree with would be arbitrarily chosen and would have little chance of corresponding with the idea in the mind of the coiner when he named his genus.

- 40 To say that *epi-gramma*, *melo-drama*, *acro-polis*, *macro-cosmus*, *leonto-cephale*, *chaen-alopex*, *Helles-pontus*, *pyx-acantha*, *hippo-dromus*, and hundreds of others are not nouns, but adjectives used substantively with some imaginable word understood, is no less absurd than to deny that *cyclo-stoma*, *di-delphys*, etc., may be nouns of the same sort and subject to the same laws. And yet that theory which would make adjectives of all these words tells us that even *mega-therium* is not a noun but a neuter adjective modifying animal or monstrum understood, and that it is subject to the inflection *megatherius*, *megatheria*, *megatherium*, etc.! It is, therefore, properly derived, we are informed, not from *μέγα+θηρίον* directly, but from a *μεγα-θήριος* sc. *θήρ*, 'a great-beastly animal.' That is, to be sure, a perfectly legitimate course to take in order to get *megatherium*, but it is no more likely that it was obtained in that way than it is that the discoverer of *cyclo-stoma* did not simply put together *κύκλος+στόμα*, but first built an adjective *κυκλόστομος, -ον*, then turned that into Latin *cyclo-stomus*, *-um*, and then arbitrarily manufactured a feminine *cyclo-stoma* to agree with *piscis*, masculine, understood! The classical precedent for forms in *-stomus*, masc. and fem., *-stomum*, neut., is *poly-stomus*, masc. and fem., *poly-stomum*, neut. The only rational way to form either would be *μέγα+θηρίον* and *κυκλο-+στόμα*. And as *cyclo-stoma* goes, so must go the rest of the words in *-stoma*, *-soma*, etc. In general, it is arbitrary and inexact to make
- 41 adjectives of three endings in Latin out of Greek adjectives of two endings. The old Latinists used the form in *-us* for

both masculine and feminine, and -um for the neuter; e. g. curo-troph-us (-os), masc. and fem., curo-troph-um (-on), neut.; dory-phorus, masc. and fem., dory-phorum, neut.; disco-phorus, masc. and fem.; eu-petalus, masc. and fem.; poly-stomus, masc. and fem., -um, neut. The only exception I find given in the Latin dictionary is di-somus, -a, -um; but that is erroneous and should read disomus, -um.

- 42     5. Family names formed from neuter names of genera in -stoma, -soma, etc., should end in -atidae not in -idae; for the stem of those words ends in -at, Greek -ατ. It is so in Latin (see p. 129): e. g. dia-phragma, gen. dia-phragmat-is, epi-gramma, gen. epi-grammatis, em-blema, gen. em-blemat-is, etc.

- 43     NOTE.—The family name from forms in -stomatus, -a, -um, would appear in the same form as that from -stoma, -stomat-is.

- 44     6. Family names formed from adjectives (used substantively) in -stomus or -stomum, -somus or -sonum, etc., end in -idae, not in -atidae. Thus Catostomus, Catostomidae.

## II. ADJECTIVES.

- 45     As a matter of course, this division will comprise by far the largest part of all Greek compounds, but not by any means all of them. Many of the compounds are genuine nouns (see §§ 39-41), and all the adjectives may be used as nouns.

- 46     In forming compound adjectives from substantives (nouns, adjectives and participles), it is not the familiar, nominative singular form of the noun, adjective or participle that is used, but the stem.<sup>1</sup> If the first element is a substantive with a stem ending in a vowel and the second begins with a vowel, the stem-vowel of the first element is, of course,

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<sup>1</sup>See § 5, with foot-note 1.

- 47 elided<sup>1</sup>; and, at the same time, if such elision brings a simple surd (κ, π, τ) up against a vowel affected by a rough breathing, that simple surd will become the corresponding aspirate (χ, φ, θ). If, on the other hand, the second element begins with a consonant, the vowel stands, and the rule is that all *a*-stems follow the analogy of the *o*-stems and
- 48 change their vowel to *-o-*. When, however, the stem of the first member ends in *-ι* or *-υ*<sup>2</sup>, the same analogy has forced itself in and *-o-* is added to the stem of the first as a connecting-vowel between it and the second member of the compound<sup>3</sup>: e. g. ἐρυθρ(ο)-όφθαλμος (ἐρυθρός, *red*, + ὀφθαλμός, *eye*), *red-eyed*; ἡμερο-δρόμος (ἡμέρα, + δρόμος, *running*), *one who runs all day*; θύρ(α)-αυλος (θύρα, *door*, + αὐλέω, *lodge*), *living out of doors*; but θυρ-ο-κόπος (θύρα, *door*, + κόπτω, *knock*), *knocking at the door*; δεχ-ἡμερος (δέκα, *ten*, + ἡμέρα, *day*), *ten-day*; νυχθ-ἡμερ-ος (νύξ, stem νυκτ-, *night*, + ἡμέρα, *day*), *night and day*; μελαν-ο-κέφαλος (μέλας, *black*, stem μελαν-, + κεφαλή, *head*), *black-headed*; λεοντ-ο-κέφαλος (λέων, stem λεοντ-, *lion*, + κεφαλή, *head*), *lion-headed*; ἱμαντό-πους (ἱμάς, stem ἱμαντ-, *strap*, + πούς, *foot*), *leather-footed*; ὄφι-ο-κέφαλος (ὄφις, *serpent*, + κεφαλή, *head*), *snake-headed*; πολι-οὔχος, i. e. πολι-ό-εχος (πόλις, *city*, stem πολι-, + ἔχω, *hold*), *city-holding*; ἰχθυ-ο-πώλης (ἰχθύς, *fish*, + πωλέω, *sell*), *fish-monger*. But when the final *υ* of the stem is part of a

<sup>1</sup>Sometimes contraction takes place: e. g. κακοῦργος (κακός + \*ἔργω), working ill; εὐνοῦχος (εὐνή, bed, + ἔχω, tend), eunuch. This would be the natural phonetic course for such combinations to follow, but it is the exception, rather than the rule, for them to do so.

49 <sup>2</sup>This rule applies to nouns only; all adjectives with stems in *-υ*, when figuring as first member of a compound, appear as bare stem without any connecting-vowel: e. g. βραχύ-πους, short-footed; βραχύ-ουρος, short-tailed; βραδύ-νους, slow of thought; ἡδύ-οσμος, sweet-smelling; ὠκύ-πους, swift-footed; and all the hosts of words beginning with πολυ-.

50 <sup>3</sup>*α*, *ε*, *ι*, and *η* occur so rarely in the middle of compound words, even before a consonant (and then, too, for the most part, in poetry), that for our purposes we may disregard them entirely. Still, good classical precedents may be found for the use of any one of them; ἰχθύς, e. g., appears in the Greek lexicon as the first member of compounds thirty-one times with an *-ο-* over against fourteen times without the *-ο-*, while the compounds of ὄφις all have the *-ο-* vowel.

diphthong, the connecting-vowel is never used: e. g. *ναυ-αγός* (*ναῦ-ς*, *ship*, +  $\sqrt{\alpha\gamma-}$ , *ἀγ-νυ-μι*, *break*), *ship-wrecking*; *βου-κέφαλος* (*βοῦ-ς*, *ox*, + *κεφαλή*, *head*), *ox-head*; *βου-κράνιον*, *ox-skull*.

- 51 The second word also is so powerfully influenced by the same analogy, that a large majority of all compound adjectives take the inflection of the -ο- declension, with two endings: -ος, masc. and fem., -ον, neuter. These usually go into Latin as -us, masc. and fem., and -um, neut.; rarely the feminine has a separate form in -a, and the neuter a form in -ον. Some have -ης, -ες, and some take the original form of the final member. The rules for the three respective cases might be drawn as follows:

- 52 1. When the final member of the compound is (a) a substantive of the first declension with stem ending in -α (nominative in -ης or -ας masc., -α or -η fem.), or (b) of the second declension with stem ending in -ο (nominative in -ος, masc. or fem., -ον, neut.), or (c) if the final member is made directly from a verbal root, the compound adjective ends in -ος, masc. and fem., -ον, neut.

(a) *ὑπερ-βόρε-ος* (*βορέ-ας*, *north*), *beyond the north*;  
*βραχυ-ουρ-ος* (*οὐρά*, *tail*), *short-tailed*;  
*οἰδί-κνημ-ος* (*κνήμη*, *shin*), *swollen-skinned*;  
*νυχθ-ήμερ-ος* (*νυκτ-*, stem of *νύξ*, *night*, + *ἡμέρα*, *day*), *night and day*;  
*κυνο-κέφαλ-ος* (*κυν-*, stem of *κύων*, *dog*, + *κεφαλή*, *head*), *dog-headed*;

(b) *τρι-δάκτυλ-ος* (*δάκτυλο-ς*, *finger*), *three-fingered*;  
*λευκ-όφθαλμ-ος* (*ὀφθαλμός-ς*, *eye*), *white-eyed*;  
*χρυσό-πτερ-ος* (*πτερό-ν*, *wing*), *gold-winged*;  
*μακρό-κεντρ-ος* (*κέντρο-ν*, *sting*), *long-stinged*;

(c) *ὑπ-ήκο-ος*, (*ἀκούω*, *hear*), *obedient*;  
*θηρ-ο-τρόφ-ος*, (*τρέφω*, *breed*), *animal-breeding*;  
*λιθο-φάγ-ος* ( $\sqrt{\phi\alpha\gamma}$ , *φαγεῖν*, *eat*), *stone-eating*;  
*ἀνθο-λόγ-ος* ( $\sqrt{\lambda\epsilon\gamma}$ , *λέγω*, *gather*), *flower-gathering*.



- 53 2. When the final member of the compound is a substantive of the third declension with the stem ending in any consonant except -ν, -ρ, -δ, or -ες (and occasionally also even then), the compound adjective (1) usually follows the same analogy and ends in -ος, masc. and fem., and -ον, neut., or (2) retains the third declensional form of the final member:

- (1) ἔν-σαρκ-ος (σάρξ, stem σαρκ-, *flesh*), *incarnate*;  
 ἄ-χρώματ-ος (χρῶμα, stem χρωματ-, *color*), *colorless*;  
 πολύ-χειρ-ος or πολύ-χειρ (χείρ, *hand*), *many-handed*;  
 πᾶμ-μην-ος (μήν, *month*, stem μην-), *lasting through all the month*;  
 (2) μικρ-ωψ (ὤψ, stem ὠπ-, *eye*), *small-eyed*;  
 ἐρι-βῶλαξ (βῶλαξ, stem βωλακ-, *clod*), *with big clods*;  
 μακρό-χειρ (χείρ, stem χειρ-, *hand*), *long-handed*;  
 δυσ-έρως (ἔρως, stem ἐρωτ-, *love*), *cherishing an unhappy love*;  
 ὀλεσί-θηρ (θήρ, stem θηρ-, *beast*), *beast-destroying*.

- 55 (a) When the final member is a neuter noun ending in -μα (stem ending in -ματ-), the compound adjective properly ends in -ματ-ος, as in the rule just given, or (as those words not infrequently in composition shorten the stem from -ματο- to -μο-<sup>1</sup>) in -μος, or we may have both the longer and shorter forms side by side; e. g.

- τρι-σώματ-ος and τρι-σωμ-ος, *three-bodied*;  
 ἄ-σώματ-ος and ἄ-σωμ-ος, *bodiless*;  
 ἄ-δέρματ-ος and ἄ-δερμ-ος, *skinless*;  
 ἄ-χρώματ-ος and ἄ-χρωμ-ος, *colorless*.

Linnaeus has forms to which the prototypes would be ἀνώστομ-ος, πολύ-νημ-ος, χρυσό-στιγμ-ος, χρυσό-στομ-ος, αἰμό-στομ-ος, γονό-στιγμ-ος, ἀργυρό-στομ-ος.

<sup>1</sup> Perhaps following the analogy of words like γράμμα, -ατος, with its parallel γραμμή, -ῆς, from which we have γραμμο-ειδής, etc.; cf. σπέρμο-βολέω, σπέρμο-λόγος, δερμό-πτερος, σωμα-ασκέω, σωμα-εραστής, etc.

The shortened forms may occur also when these words are used as first members of compounds: e. g.

σπερματ-ο-λόγ-ο-ς and σπερμ-ο-λόγ-ο-ς, *seed-collecting*;  
 σπερματ-ο-φάγ-ο-ς and σπερμ-ο-φάγ-ο-ς, *seed-eating*;  
 σωμάτ-ηγ-ο-ς but σωμ-εραστής;  
 αίματ-ό-πους (L.) but αίμ-ό-πτερ-ο-ς (L.);  
 αίματ-ώδης (L.) but αίμ-ό-στομ-ο-ς (L.).

- 56 (δ) When dealing with this class of neuter nouns, therefore, we may be entirely justified in using whichever form may happen to suit our fancy, and say *dermato-*, *spermato-*, *haemato-*, *somato-*, etc., or *dermo-*, *spermo-*, *haemo-*, etc., as we will. Numerically, the Greek lexicon reveals a preference for the longer form as first member of a compound, and for the shorter form in the final member.

(c) For the inflection of these adjectives and the formation of family names derived from them and from the corresponding nouns, see pp. 127-132.

- 57 3. When the final member is a substantive of the third declension, with a stem ending in -ν, -ρ, or -δ (which is always dropped by law before the -ς of the nominative singular), the compound adjective usually retains the form and inflection of the last member: e. g.

κακο-δαίμων, *possessed of a bad spirit*;  
 αὐτό-χθων, *sprung from the earth itself*;  
 φιλ-έλλην, *Greek-loving*;  
 πολύ-χειρ, *many-handed*;  
 ἄ-παις (ἄ- privative + παῖ(δ)ς, *child*), *childless*;  
 ῥίψ-ασπις (ῥίπ-τω, *throw*, + ἄσπις, stem ἄσπιδ-, *shield*),  
*throwing away one's shield*;  
 ἄ-πους (ἄ- privative + πούς, for + \*πο(δ)ς, *foot*), *footless*;  
 ἱμαντ-ό-πους (ἱμάς, stem ἱμαντ-, *leather strap*, + \*πο(δ)ς, *foot*), *leather-footed*; so also λαγώ-πους, *hare-footed*;  
 βραδύ-πους, *slow-footed*; ἐρυθρό-πους, *red-footed*;  
 χλωρο-πους, *green-footed*; etc.

- 58 (a) All words in -pus (Greek -πους) have the stem in -pod; the genitive ends as in Latin in -pod-is, the plural in -pod-es. The family name will, therefore, end in -pod-idae. The Latin lexicon reveals forms like

echino-pus, gen. -pod-is; chytro-pus, gen. -pod-is;  
haemato-pus, " -pod-is; clino-pus, " -pod-is;  
himanto-pus, " -pod-is; Oedi-pus, " -pod-is;  
lago-pus, " -pod-is; tri-pus, " -pod-is.

There is no exception; corono-pus has genitive -podis, but accusative -pum. Poly-pus, -i, has also Greek πολύπος, πολύπου, as archetype.

- 59 (b) In the same way the words in -n and -r (Greek -ν and -ρ) have the genitive in -n-is and -r-is, the plural in -n-es and -r-es, and the family names in -n-idae and -r-idae.

- 60 4. When the final member is a substantive of the third declension, with a stem ending in -ες (nominative in -ης, masc. or fem., -ος, neut.), the compound adjective will end in -ης, masc. and fem., and -ες, neut.: e. g.

δι-έτης (ἔτος, stem ἔτεσ-, *year*), *biennial*; so τρι-έτης, *triennial*;

λυσι-μελής (μέλος, stem μελεσ-, *limb*), *limb-relaxing*;

νη-κερδής (κέρδος, stem κερδεσ-, *gain*), *bootless*.

Linnæus seems to use as adjectives the noun forms oxy-rincus (*sic*) (pp. 512, 395), gono-ryn-chus (p. 528), callo-rynchus (p. 402), syn-gnathus (p. 416).

- 61 (a) When the last member of such a compound is εἶδος, preceded by an -ο-, the -ο-+εἶδες may contract to -ωδες: e. g.

τριχ-ο-εἰδής or τριχ-ώδης, *hairlike*;

κητ-ο-εἰδής or κητ-ώδης, *cetacean*;

κυκλ-ο-εἰδής or κυκλ-ώδης, *cycloid*;

γογγυλ-ο-εἰδής or γογγυλ-ώδης, *roundish*.

- 62 5. When the final member is a neuter noun of the third declension with stem ending in -ατ- (nominative singular in -ας), the compound adjective will end in -ως (contracted from -α(τ)ος) for the masc. and fem., and -ων for the neut.; but (α) sometimes it follows the analogy of the adjectives in -ος, -ον: e. g.

γλυκύ-κρεως, -ων or γλυκύ-κρε-ος, -ον, *sweet-meated* (κρέας; stem, κρεατ-);  
 μονό-κερως or μονό-κερος, *one-horned* (κέρας; stem, κερατ-);  
 ἀ-γήρως (γῆρας, *age*), *ageless*; but  
 ὀρθό-κερ-ος, *upright-horned*; ῥινό-κερως, *horn-nosed*; etc.

- 63 6. When the final member is a substantive of the third declension with a stem ending in the vowel -ι- or -υ- (nominative singular -ις, -υς, masc. or fem., and -ι or -υ, neut.), the ending of the compound will appear identical with the form of the final member: e. g.

σωσί-πολι-ς (πόλις, *city*), *city-saving*;  
 περσέ-πολι-ς (πόλις, *city*), *city-destroying*;  
 ὀφι-όψι-ς (ὄψις, *look*), *looking like a snake*;  
 λιπό-ναυ-ς (ναῦς, *ship*), *ship-abandoning*;  
 δί-πηχυ-ς (πῆχυς, *cubit*), *two cubits long*;  
 \*ἄ-δελφυ-ς (δελφύς, *womb*), *wombless*; etc.

- 64 7. When the final member is a verbal root, it may have either an active or a passive force; (α) if active, the compound may have the simple verbal root with the endings  
 65 -ος, -ον; (β) if passive, it will usually have the suffix  
 66 -τος; (γ) it may have the ending -ης, which is either active or passive: e. g.

(α) θηρ-ο-τρόφ-ος ( $\sqrt{\tau\rho^e}/\phi$ , τρέφω, *breed*), *animal-breeding*;  
 ὕλ(α)-ο-τόμ-ος ( $\sqrt{\tau^e}/\mu$ , τέμ-ν-ω, *cut*), *wood-cutting*;  
 οὐραν-ο-σκόπ-ος (σκοπ-έω, *see*), *sky-gazing*;

- (b) κατά-φρακ-τος ( $\sqrt{\text{φραγ}}$ , φράσσω, *cover*), *covered over*;  
 δορυ-άλω-τος ( $\sqrt{\text{ἄλω}}$ -, ἄλίσκομαι, *be taken*), *taken with the spear*;  
 ἀ-λεπίδω-τος (\*λεπιδόω, *cover with scales*), *not covered with scales*; so  
 μακρο-λεπίδω-τος, ἄ-γνω-τος, Ἀρητ-φα-τος, etc.
- (c) εὐ-μαθ-ής, *easily learning*, or *easily learned*;  
 ἀ-μαθ-ής, *not learning*, or *not learned*;  
 θεο-σεβ-ής, *reverencing the gods*.

The principal classes of Greek compound adjectives, the formation of which is concerned in this discussion, are not different from the classes of Latin compounds discussed in §§ 23-29 and will be treated in the same way. They are as follows:

	Noun-stem	+	Connecting-vowel	+	Noun-stem	(+ Connecting-vowel)	+	Case-ending
67	I.	λεοντ-		ο-	κέφαλ(α)ο-			ς, <i>lion-headed</i> ;
		ἵππ(ο)-			οὐρ(α)ο-			ς, <i>horse-tailed</i> ;
		πάμ-			μην-	ο-		ς, <i>all the month</i> ;
		κυν-		ό-	γλωττ(α)ο-			ς, <i>dog-tongued</i> ;
		κυν-		ο-	κέφαλ(α)ο-			ς, <i>dog-headed</i> ;
		ρόδο-			δάκτυλο-			ς, <i>rosy-fingered</i> .

- 68 The process would be exactly the same for two adjectives combined into one; or for an adjective with an inseparable prefix:

ἐρυθρό-λευκο-ς, *reddish white*;  
 λευκο-μέλα(ν)-ς, *black and white*;  
 πολύ-χλωρο-ς, *very green*;  
 ἀν-αίτιο-ς, *not to blame*; ἄ-σοφο-ς, *unwise*; etc.

	Prefix	Noun-stem	( + Connecting-vowel )	Case-ending
69	2.	ἄμφι-βιο-		ς, <i>amphibious</i> ;
		ἄ-σώματ-	ο-	ς, <i>bodiless</i> ;
		ὑπό-λευκο-		ς, <i>whitish</i> ;
		ἄ-δεσμο-		ς, <i>unbound</i> ;
		ἄ-χρώματ-	ο-	ς, <i>colorless</i> ;
		ἡμί-πτερο-		ς, <i>half-finned</i> .
	Adjective-stem	Noun-stem	( + Connecting-vowel )	Case-ending
70	3.	μάκρ(ο-)οὐρ(α)ο-		ς, <i>long-tailed</i> ;
		τρι-σώματ-	ο-	ς, <i>three-bodied</i> ;
		περκνό-πτερο-		ς, <i>dark-winged</i> ;
		λευκ(ο-)όφθαλμο-		ς, <i>white-eyed</i> .

71 (a) Numeral adjectives follow an abnormal course:

(1) Instead of the numeral εἷς, μία, ἕν, in composition, *μόνος*=single, is used: e. g. *μονό-γαμος*, *married but once*; *μονό-ζυξ*, *single-yoked*; *μονό-κερως*, *having but one horn*.

(2) For δύο- there is an inseparable prefix δι- which is always used in compounds: e. g. *δι-δάκτυλος*, *two-fingered*; *δι-όδων*, *two-toothed*; *δι-πτερος*, *two-winged*; *δι-έτης*, *biennial*.

(3) The stem of *τρεῖς*, *τρία*, is *τρι-*, which is simply prefixed in entering into composition: e. g. *τρι-σωμος*, *triple-bodied*; *τρι-δάκτυλος*, *three-fingered*; *τρι-γωνος*, *three-cornered*.

(4) *τέτταρες* has also an inseparable prefix form *τετρα-*: e. g. *τετρα-δάκτυλος*, *four-fingered*; *τετρα-γωνος*, *four-cornered*; *τετρα-έτης*, *quadriennial*.

(5) and (6) πέντε and ἑξ follow the analogy of τετρα- and ἑπτά, and make prefixes πεντα- and ἑξα- respectively: πεντα-δάκτυλος, *five-fingered*; ἑξα-δάκτυλος, *six-fingered*.

(7) ἑπτά, ὀκτώ, etc., are simply prefixed without change.

- 72 NOTE.—Πᾶν in composition is usually treated as a neuter substantive, with stem παν- instead of παντ-, in an adverbial relation to the other member of the compound: e. g. πᾶν-σοφος, *all-wise*, παν-σέληνος, *full-mooned*; πᾶν-μηνος, *through all the month*; Παν-έλληνες, *the Grecian world*; rarely παντ-ο-: παντ-ο-δαπός, *all sorts of*; παντ-ο-πόρος, *all-traversed*.

		Noun-stem ( + )	Connecting-vowel	Verb-stem ( + )	Connecting-vowel	Case-ending
73	4.	αἰμ-	ό-	ρρο-	ο-	ς, <i>flowing with blood</i> ;
		τοπο-		γράφ-	ο-	ς, <i>place-describing</i> ;
		λιθο-		φάγ-	ο-	ς, <i>stone-eating</i> ;
		οὐρανο-		σκοπ-	ο-	ς, <i>sky-gazing</i> ;
		βραγχιο-		στέγ-	ο-	ς, <i>gill-covered</i> .
		Prefix ( + )	Verbal-root	( + )	Connecting-vowel	Case-ending
74	5.	ᾶ-	τροπ-		ο-	ς, <i>not turning</i> ;
		ἀνά-	βλεπ-			ς, i. e. βλέψ, <i>looking up</i> ;
		ἔν-	τροφ-		ο-	ς, <i>living with</i> ;
		ᾶ-	τομ-		ο-	ς, <i>uncut</i> ;
		διχό-	τομ-		ο-	ς, <i>cut in two</i> .

Exceptions to these rules will be found, of course, not only in scientific nomenclature, but even in well approved classics. All that has been attempted here has been to give

the rule, leaving the abnormal to take care of itself. As I have given the rule and ignored the exceptions for the most part, even where exceptions are numerous, the laws laid down may be called "Draconian," and censured as being "tinctured with more than Roman severity." But the "frequent laments over the instability of our systematic nomenclature" and the "bitter complaints against those who change names" are called forth in nearly every case by some one's having rebelled against some "Draconian" law. Consistency and correctness can be secured only by following out what is recognized as rule, and will surely be thwarted by adopting strange forms even when sanctioned by sporadic use on the pages of a Pliny. Nothing is good enough but the best, whether in science or language or Latin form for scientific nomenclature; and Pliny, for the last, is not good enough so long as we have something better. I cannot refrain from concluding with the rest of Dr. Gill's paragraph, alluded to above, in which, after objecting so vigorously to what he calls "Draconian" laws and "laws tinctured with more than Roman severity" and urging that "the language of nomenclature should not be bound by rules of strict philology," he declares so unequivocally for humble obedience to the higher law of priority as the only way out of utter confusion: "Frequent are the laments over the instability of our systematic nomenclature; bitter the complaints against those who change names. But surely such complaints are unjust when urged against those who range themselves under laws. We are forcibly reminded by such complaints of the ancient apologue of the wolf and the lamb. The stream of nomenclature has indeed been muddied, but it is due to the acts of those who refuse to be bound by laws or reason. The only way to purify the stream is to clear out all the disturbing elements. In doing so, mud that has settled for a time may be disturbed, but that is at worst anticipating what would have inevitably happened sooner or later. We are suffering from the ignorance or misdeeds of the past. In opposing the necessary rectifications and the enforcement of the



laws, extremes may meet ; conservatives and anarchists agree. But the majority may be depended upon in time to subscribe to the laws, and the perturbed condition will then cease to be."

We may recognize the law of priority as absolute, and retain the many monstrous and misspelled names to be found on the records of natural history, just as their makers left them. They are historic facts and serve to mark the group of animals or plants to which they apply, but these misshapen forms of words are not ornamental and they are unworthy of scholars. It is to be hoped that, in future, greater care may be taken to make words that give correctly the idea the author may have intended. Such words as *Felichthys*, *Lepomis*, *Semotilus* demand the constant apology of those who use them, while words like *Zalophus*, *Eri-cymba*, *Hylocichla* are a pleasure in themselves to those who understand their meaning. It costs no more to frame a name properly than to leave it a monstrosity.

If this paper shall serve as a stepping-stone toward the attainment of correctness and uniformity in the framing of names of classical origin, its purpose will be fully met.







PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES

ZOOLOGY.                      THIRD SERIES.                      VOL. I, No. 3.

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SCIENTIFIC NAMES OF LATIN AND  
GREEK DERIVATION.

BY  
WALTER MILLER,  
*Professor of Classical Philology, Leland Stanford Jr. University.*

*Issued April 10, 1897.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1897.

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## SCIENTIFIC NAMES OF LATIN AND GREEK DERIVATION.

BY WALTER MILLER,

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While the first volume of Jordan and Evermann's "Fishes of North and Middle America" was in preparation, Dr. Jordan invited me to review and verify the etymologies of the names of the fishes described. In the course of this review some of the inconsistencies into which nomenclators have

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### NOTE BY THE PUBLICATION COMMITTEE.

Since systematic botany and zoology will necessarily occupy a prominent place in biological investigation in Western North America for many years to come, it has seemed to the Publication Committee that a comprehensive, and at the same time readily accessible and reliable, treatise on the rules that should govern the selection and formation of scientific names derived from Greek and Latin would be especially useful to local botanists and zoologists. To meet this desideratum is the chief motive of the paper here presented. It is hoped, however, that it may have a usefulness beyond the purpose for which it is primarily published.

**appears in compounds and in family names in a sadly mutilated form.**

Various scientific writers have arbitrarily departed from the philologically correct method of nomenclature established by Linnæus;<sup>1</sup> moreover some difference of opinion

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<sup>1</sup>Even Linnæus, however, is not absolutely free from errors in transliteration: e. g. *Systema Naturæ*, 1<sup>st</sup>: Oxy-rinchus (pp. 395 and 512), Callo-rynchus (p. 402), Gono-rynchus (p. 528), Di-delphis (p. 71), Syn-gnathus, as masculine (p. 416).

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While the first volume of Jordan and Evermann's "Fishes of North and Middle America" was in preparation, Dr. Jordan invited me to review and verify the etymologies of the names of the fishes described. In the course of this review some of the inconsistencies into which nomenclators have fallen in the construction of names of classical derivation came frequently under discussion. Two sets of words seemed to cause more trouble than any others: what should be the gender and inflection of compounds in -pus (genitive, -podis) and -stoma, -soma, etc. (genitive, -stomatis, -somatis, etc.), and what the form of the family names to be derived from them, were the questions that called for an immediate answer. As thorough an investigation as possible followed and a satisfactory conclusion was reached. But the examination of the problems these questions presented naturally suggested others in regard to the formation, gender and inflection of New Latin compound names; for most of the irregularities in scientific nomenclature are of that sort. Here and there we find masculine nouns in -a (genitive, -ae) masquerading as feminine, feminine nouns in -us (genitive, -i) and neuters in -us (genitive, -us, Greek -ους) as masculine, and neuters in -ma (genitive, -matis, Greek -ματος) as feminines in -a (genitive, -ae). Again, through a misconception of the inflection of a word it often appears in compounds and in family names in a sadly mutilated form.

Various scientific writers have arbitrarily departed from the philologically correct method of nomenclature established by Linnæus;<sup>1</sup> moreover some difference of opinion

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now prevails in regard to the formation, gender and inflection of certain New Latin words derived from the Greek. Definite rules have been wanting, or at least not readily available. Accordingly, at Dr. Jordan's request, and with his kind assistance, I have undertaken to formulate a set of rules based upon philological principles and at the same time agreeing with the practice of consistent nomenclators. Ultra-purism, however, as the writing of *ai* and *oi* for the Greek *αι* and *οι* or of *k* for Greek *κ*, shall have no more consideration than the philological monstrosities produced by a Rafinesque or a Swainson.

- 1 There is no essential difference in the method of procedure whether we are adopting from the classical languages simple words or compound words; but as not all the desired compounds exist ready made for us in Greek and Latin, and as their formation causes more trouble, the compounds will be assumed as the subject of these rules.
- 2 Compounds in scientific terminology, whether Latin or Greek, are usually made up of two parts, which would naturally be separate words standing in some syntactical relation to each other and which combine that relation in one word; either member may be a form that is not a word by itself but appears only in compounds: e. g. Eng. *un-*told; *un-* appears only as inseparable prefix; in *up-ward* *-ward* appears only as inseparable suffix. So Latin *ve-*sanus (inseparable prefix *ve-* + *sanus*) out of one's senses; *fun-**ambulus*, rope-walker; Greek *δυσ-άλωτος*, *hard to be caught*; *πολυ-πράγμων* (*πολύ*, *much*, + *πράττω*, *do*), meddlesome.
- 3 Besides these two elements, a third is in every case to be taken into consideration—the inflectional ending, which determines the sentence relation of the word; this inflectional ending may or may not be identical with that of the last member of the compound: e. g. in *λευκ-όφθαλμος* (*λευκός*, *white*, + *όφθαλμός*, *eye*), *white-eyed*, and in *Πελοπόν-νησος* (*Πέλοπος*, *Pelops'*, + *νήσος*, *island*), Peloponnesus, it is; but it is not so in *μακρο-κέφαλος*, *long-headed*, derived from *μακρός*, *long*, + *κεφαλή*, *head*, nor in *μακρ-ούρος*, *long-tailed*, derived from *μακρός*, *long*, + *οὐρά*, *tail*; but in passing into

a compound adjective the stem *κεφαλα-* of *κεφαλή* and the stem *οὔρα-* became, after the irresistible analogy of the *ο-* stems, *κεφαλο-* and *οὔρο-*, and to those stems the masculine nominative case-ending *-ς* was added. Such changes will be more apparent as we proceed.

#### HYBRID WORDS.

- 4 In building a compound name the two classical languages should never be mixed. The new word should be wholly Greek or wholly Latin. Hybrid words are always objectionable, and such compounds as Swainson's *Felichthys*, as *Longicephalus*, *Leptogunnellus*, *Flavigasser*, *Gymnocorvus*, *Arboro-phila* and the like, are enough to make one's hair stand on end.

#### LATIN COMPOUNDS.

Latin is, comparatively speaking, poor in compound words. In place of doubling up words, significant suffixes are added, or the words, retaining their proper syntactical relations, are simply written together as one: e. g. *pater-familias*, *iuris-dictio*, etc. Still, the language contains many genuine compounds of every part of speech—substantives, verbs and adverbs.

- 5 In entering into composition as first member of a compound, a noun or adjective appears not in its familiar, nominative singular form, but as its stem or a modification of its  
6 stem.<sup>1</sup> If the stem ends in a vowel and the second member begins with a vowel, the vowel of the first is elided: e. g. *somn-ambulus* (*somnus*, stem *somno-* + *-ambulus*),

<sup>1</sup>But less than the stem must not be used in any case; no change in a word may be made except in the variable terminations. "A name made up of the first half of one word and the last half of another is as deformed a monster in nomenclature as a mermaid or a centaur would be in zoölogy." A worse linguistic monstrosity than *Cor-corax* (from *Corvus* and *Πυρρο-κόραξ*), both hybrid and mutilated at that, it would be difficult to conceive; and yet it stands. Other examples of the same violation of law we have in *Cypsnagra* (*κύψελος* + *Τανάγρα*), *Merulaxis* (*Merula* + *Συνάλλαξις*), *Bucorvus* (*Βουκέρω* + *Corvus*), etc.

magn-animus (magnus, stem magno- + animus).<sup>1</sup>

- 7 But if the second member of the compound begins with a consonant, the final vowel of the first member will appear as i. For even in the case of *a*, *o*-<sup>2</sup> and *u*-<sup>3</sup> stems the final vowel is, in accordance with well known phonetic laws, naturally weakened to -i- [man-ceps, *contractor*, and man-cipium, *contract* (derived from manus, *hand* + capere, *take*) have lost even the -i-]: e. g.

tub-i-cen (tuba, *horn*, + can-ere, *sing*), *horn-player*;

curv-i-rostris (curvus, stem curvo-, *curved*, + rostrum, *beak*), *having a curved beak*;

spin-i-barbus (spina, *spine*, + barba, *beard*), *having a beard of spines*;

hort-i-cola (hortus, stem horto-, *garden*, + col-ere, *dwelling*), *dwelling in a garden*;

navi-ger (navis, stem navi-, *ship*, + ger-ere, *bear*), *ship-bearing*;

corn-i-ger (cornu, stem cornu-, *horn*, + ger-ere, *bear*), *horn-bearing*.

- 8 In the case of stems in -io-, the *o* simply falls out and leaves the first member ending in -i-, as in the other cases: e. g.

<sup>1</sup>Forms like multi-angulus (side by side with mult-angulus) are of later manufacture and the result of analogy with forms where no hiatus occurs.

<sup>2</sup>Where -o- appears in the junction of compounds, it is due to the influence of the Greek compounds: e. g. albo-galerus, *the flamen's hat*; unomammus, *single-breasted*. Accordingly, such formations as albo-caudatus, *white-tailed*, as participial form to albi-cauda (adjective), or rubropunctatus, *red-spotted*, or rubro-vinctus, might be perfectly legitimate in epic poetry but not in Latin prose nor in strictly correct New Latin construction.

<sup>3</sup>A -u- seems sometimes to remain unchanged: e. g. nau-fragus (navis, stem navi-, + √frag, *frangere*, *to break*), *ship-wrecking*, for navi-fragus, arose in the same way as Greek ναυ-αγός, and in the same way bu-caeda (cf. bovi-caedium) and bu-mammus were made after the analogy of the Greek compounds of βουής; manu-mitto, manu-factus, etc. are not due to composition, properly speaking, at all, but to juxtaposition, manu- being not the stem but the ablative case.

medi-terraneus (medius, stem medio-, *middle*, +  
terra, *land*), *between lands*;  
heredi-peta (heredium, *legacy*, +pet-ere, *hunt*),  
*legacy-hunter*;  
offici-perda (officium, *office*, perd-ere, *lose*),  
*labor-losing*.

- 9 The same analogy has forced itself through in the case of  
consonant stems as well, so that a connecting vowel *-i-* is  
inserted between the consonant stem and the second mem-  
ber:<sup>1</sup> e. g.

part-i-ceps (pars, stem part-, *part*, +cap-ere,  
*take*), *sharing*;  
dent-i-frangibulus (dens, stem dent-, *tooth*, +  
frang-ere, *break*), *tooth-breaking*;  
soror-i-cida (soror, stem soror-, *sister*, +caed-  
ere, *kill*), *sister-slayer*;  
fratr-i-cida (frater, stem fratr-, *brother*, +caed-  
ere, *kill*), *brother-slayer*.

The treatment of the first member is the same for both  
nouns and adjectives.

- 10 The final member of a Latin *substantivum compositum*  
may be a substantive (noun, adjective, participle) or a verb,  
and the whole will appear, according to the will of the  
coiner, as noun or adjective; its form will be decided by

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<sup>1</sup> Rarely, instead of adding *-i-*, the consonant stem loses its consonant: e. g.  
iu-dex, (ius, stem iur-, *law*, +dic-ere, *speak*); but it seemed unnatural  
and so a iur-i-dic-us was made according to rule, with the same mean-  
ing; in the same way lapi-cida (lapis, stem lapid-, *stone*, +caed-ere,  
*cut*) was also followed in due time by the normal lapid-i-cida, *stone-cutter*.

The forms with the connecting vowel *-i-* are by far the most numerous;  
they are the only ones that we may take as our models, for, analogous forms  
though they are, they represent the only method of formation in use in class-  
ical times. The older method, of which only a few specimens are left, was  
simply to prefix the stem of the first member to the second and leave the con-  
sonant to take care of itself: e. g.

sol-stitium (sol), *solstice*;  
mus-cipula (mus), *mouse-trap*;  
nomen-clator (nomen), *name-caller*.

the form of the final member. If the whole is to be a NOUN, its form will be governed by the following rules:

- 11     1. If the final member of a Latin *nomen compositum* is a noun, the compound noun will have the form and gender and inflection of that noun: e. g.

pro-avus, -i, masc. (avus), *great-grandfather* ;  
 decem-vir, -i, masc. (vir), *decemvir* ;  
 de-decus, -oris, neut. (decus), *disgrace* ;  
 meri-dies, -ei, fem. (dies), *midday* ;  
 bi-dens, -dentis, masc. (dens), *fork*.

- 12     2. If the final member of a Latin *nomen compositum* is a  
 13 verbal root, the compound noun will be (a) a masculine  
 noun of the first declension ending in -a, (b) a noun of the  
 third declension: e. g.

(a) agri-col-a, -ae (ager, *field*, + col-ere, *till*),  
*farmer* ;  
 fratri-cid-a, -ae (frater, *brother*, + caed-ere,  
*slay*), *fratricide* ;  
 lapi-cid-a, -ae (lapis, *stone*, + caed-ere, *cut*),  
*stone-cutter* ;  
 (b) tibi-cen, -cinis (tibia, *flute*, + can-ere, *sing*),  
*flute-player* ;  
 man-ceps, -cipis (manus, *hand*, + capere  
*take*), *contractor* ;  
 iu-dex, -dicis (ius, *right*, + dic-ere, *speak*),  
*judge*.

- 14     In forming compound ADJECTIVES, the final member, as well as the first, is strongly influenced by the analogy of the *i*- stems, so that we have compounds with stems in -o- and -a- (nominative singular in -us and -er, masc., -a, fem., -um, neut.), with stems in -i- (nominative singular in -is, masc. and fem., -e, neut.), and with stems ending in a consonant (nominative singular in -s, preceded by a consonant, or in -r), according to the following rules:

**PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES**

**ZOOLOGY.** **THIRD SERIES.** **VOL. I. No. 4.**

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**A Genus of Maritime Dolichopodidæ  
New to America.**

**BY  
WILLIAM MORTON WHEELER, PH. D.**

**WITH ONE PLATE.**

*Issued July 10, 1897.*

**SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1897.**





## A GENUS OF MARITIME DOLICHOPODIDÆ NEW TO AMERICA.

BY WILLIAM MORTON WHEELER, PH. D.

### PLATE IV.

OF THE three maritime genera of Dolichopodidæ described from Europe, viz., *Machærium*, *Thinophilus* and *Aphrosylus*, only one has hitherto been found to be represented in this country. This is *Thinophilus*, of which I described a species from Wyoming during the past year.<sup>1</sup> While working on the marine fauna of Monterey, California, during the summer of 1896, and again during January of this year, while similarly engaged at San Diego, California, I observed three species of Dolichopodidæ flitting about in the spray of the breakers among the sea weeds on the rocks below high water mark. Closer examination shows that the three species are all new, and that they are assignable to *Aphrosylus* Walker, a genus comprising four European species: *A. ferox* Walk., *A. celtiber* Hal., and *A. raptor* Walk., from the sea coasts of Northern Europe, and *A. venator* Loew, from the coast of Italy.

Loew<sup>2</sup> sums up the characters of the genus *Aphrosylus* in the following words: "The first joint of the antennæ without hair, the second of the usual transverse form, the third tapering at the tip; the arista entirely apical. The face narrowed above, especially in the male. The proboscis turned towards the breast. Palpi disengaged, hanging downward, in the male larger than in the female. The abdomen of the male shows six segments; the short and rounded hypopygium ends in the shape of a knob; its external appendages are elongated, parallel lamellæ, fringed with rather long hair. The female abdomen has only five segments. Wings of rather equal breadth; the posterior

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<sup>1</sup> Ent. News, May, 1896, pp. 155-156.

<sup>2</sup> Monograph of N. Am. Dolichopodidæ. Smith. Misc. Coll., 171, 1864, p. 148.

In all these characters the Californian species agree with their European congeners. They may be distinguished from one another thus:

- a.* Arista of the antenna naked, posterior cross-vein at right angles to the fourth vein ..... *b.*  
Arista pubescent, posterior cross-vein forming an obtuse angle with the fourth vein. .... *Aphrosylus grassator.*  
*b.* Wing with a black blotch covering the distal end of the discal cell, fore and hind femora ciliated above. .... *A. direptor.*  
Wing without a black blotch, fore and hind femora eciliate. .... *A. prædator.*

PLATE IV, FIGS. 1-6.

*Male*.—Length of body 2-3 mm; length of wing 2.5-3 mm. Antennæ black, first joint rapidly widening distally, second short, spheroidal, with black bristles, third tapering rather uniformly from a broad base to a point, and covered with short hair and with a few scattered, short, spine-like bristles, which are more numerous on the ventral than on the dorsal surface. The two-jointed arista is long and flexuous, its basal segment about one-third as long as the third antennal joint and, like this joint, covered with short hairs; the apical segment bare. Face metallic green, thickly covered with gray dust, narrow towards the middle where there is a distinct indentation at the orbit on either side. The lower portion of the face projects forward somewhat. Palpi large, black, with black hairs. Proboscis swollen, cylindrical. Posterior orbit metallic green, with thick gray dust and black cilia. Thoracic dorsum metallic green overlaid with a thick layer of brown dust; the dorsal and acrostichal bristles prominent, black. Pleuræ black, with or without very slight metallic green reflection, covered with gray dust. Scutellum of the same color as the thoracic dorsum, with four bristles, the median pair long and thick and directed upwards and forwards; the lateral pair small and weak and directed backwards. Abdomen suddenly narrowed at the fourth segment, above metallic green, somewhat less opaque than the thoracic dorsum, and covered with black hairs, below blackish and covered with pale dust and hairs like those on the dorsal surface. What is to all appearances a rudiment of the seventh abdominal segment overlaps the base of the hypopygium on the left side. Hypopygium large, its swollen base black, without hairs; the pair of external appendages bent forwards at a right angle

near their tips, black. Each of these appendages bears a piceous or gray lamella on its antero-lateral edge above the angle. This lamella is fringed along its edge with weak hairs, the appendages with stubby black bristles, which are especially abundant on the mesial surfaces. The inner appendages are yellowish, the sinuate penis short and broad, with its point directed forwards. In life the hypopygium is folded up against the ventral surface of the fourth to sixth abdominal segments, somewhat like the blade of a closed pocket-knife. In this position both the inner appendages and the tips of the outer appendages are invisible. Legs black (in alcoholic specimens piceous), with a dull metallic green reflection, especially on the femora, and bristly with black hairs. The ground color of the legs is obscured by a layer of pale dust. Fore coxæ with conspicuous black hairs on their anterior surfaces; fore femora somewhat thickened proximally, with about a dozen prominent black spines below directed at right angles to the surface. The fifth joint of all the tarsi somewhat broader than the other tarsal joints. First joint as long or nearly as long as the second to fourth joints taken together. Fore tibia with a strigil-like comb of pale hairs near its distal end on the inner side. Hind femur with a few long bristles near its tip on the outer side; middle tibia with a few similar bristles near the proximal end on the outer side. Wings gray, rather opaque, with faint traces of a darker cloud on the posterior cross-vein, which is at right angles to the fourth longitudinal vein and scarcely more than its own length distant from the posterior margin. Terminal segments of the second to fourth veins parallel and slightly bent. Sixth vein short but distinct. Anal angle of the wing not very prominent. Halteres pale yellow throughout. Upper cilia of the piceous tegulæ white, lower cilia black.

*Female*.—Length of the body 3-3.5 mm.; length of wing 3.5-4 mm. Differs from the male in having a somewhat broader face, in the absence of the spines on the lower surfaces of the fore femora, and in the shape of the abdomen, which is much swollen in my specimens and consists of only five visible segments. Its tip, provided with the small black or piceous ovipositor, is turned upwards.

Of this, the most abundant of the three species, I have collected 200 specimens, 100 of either sex. The flies are gregarious, and seem to feed on the small animals which they find among the fronds of the *Fucus* and *Endocladia* on the rocks. The females are more common than the males. From July 1st to August 5th, 1896, this species was observed almost daily at Pacific Grove, California, and along the coast to the southward as far as Point Lobos. It was also seen, January 15th to March 10th, in smaller numbers, at Point Loma and La Jolla, San Diego County, California. It will probably be found to occur throughout California wherever the coast is rocky.

**Aphrosylus direptor, sp. nov.**

PLATE IV, FIGS. 7-10.

*Male*.—Length of body 2.5 mm.; length of wing 3.5 mm. Face dull metallic green, rather thickly covered with pale dust, palpi somewhat smaller than in the preceding species, black, with black hairs. Antennæ black, first and second joints as in the preceding species, third joint shorter and more oblong, owing to a blunt projection on the ventral side near the insertion of the arista; basal segment of the arista short, hairy; apical segment long and bare. There are a few prominent bristles on the third joint similar to those found in *A. prædator*. Cilia of the superior and inferior orbits black, not very prominent. Thoracic dorsum metallic green, opaque, with a thick layer of brownish dust; acrostichal and dorsal bristles prominent, black. Pleuræ and scutellum as in *A. prædator*. Abdomen metallic green, overlaid with white dust and covered with short black hairs; the six segments are of nearly uniform length and taper gradually to the insertion of the hypopygium. Hypopygium smaller than in the preceding species. Its swollen and hairless base bears the scale-like rudiment of the seventh segment on the left side. The pair of outer appendages is considerably shorter than in *A. prædator* and directed forwards from their insertions. They are black and covered with black bristles, those on the mesial surfaces being short and stubby. The yellowish inner appendages are concealed, with the exception of the penis, which is long and delicate, and passes backwards between the outer appendages, so that its recurved end projects a short distance beyond the tip of the abdomen. Legs dull metallic green, blacker distally, covered with pale dust and black bristly hairs. Fore coxæ with conspicuous black hairs on their front faces, fore femora thickened proximally, without spines on their lower faces, but with a row of long black cilia along their upper surfaces. The strigil-like comb of pale hairs near the tip of the fore tibia is more prominent than in *A. prædator*. Hind femur with a row of black cilia on the upper surface of its proximal half. Wings without prominent anal angle, gray, somewhat opaque; venation as in the preceding species. A large black blotch covers the distal end of the discal cell and the posterior cross-vein, and extends up half-way between the third and fourth veins. Halteres dull light yellow. Cilia of the tegulæ black.

*Female*.—Length of body 3-3.5 mm.; length of wing 3.5-4 mm. Apart from the primary sexual characters the female differs from the male only in having a somewhat broader face. The female even has the cilia on the fore and hind femora, a character which we should hardly expect to find in this sex.

The above description is drawn from one male and six female specimens. These were taken in company with *A. prædator* at Pacific Grove, California, July 5th and 31st. Though rarer than the last mentioned species, *A. direptor* was frequently observed flying about among the sea weeds. In the living insect the black spots of the two wings coincide

when these appendages are folded over the back, and the additional intensity which the blotch thus acquires enables one to recognize the species at a distance of a few feet.

***Aphrosylus grassator*, sp. nov.**

PLATE IV, FIGS. 12, 13.

*Male*.—Length of body 1.5 mm.; length of wing 2 mm. Antennæ black, third joint very short, beset with short hairs and a few black bristles, which, as in the two preceding species, are more numerous on the ventral than on the dorsal surface. Arista long, distinctly pubescent throughout. Palpi not very much enlarged. Body opaque black throughout. Frontal bristles long and prominent, as are also those on the thoracic dorsum and abdomen. Bristles of the scutellum as in the preceding species. Hypopygium large, its outer appendages directed forwards and bent upwards at their tips, which are provided with two short, conical projections. The outer appendages are fringed with very dense and coarse black hairs, especially on their mesial surfaces. The inner appendages are yellowish, and the penis projects backwards and downwards between the outer appendages but not as far as in *A. director*. The bristles of the abdomen end on the rudiment of the seventh segment, which, as in the preceding species, is shifted to the left side of the swollen base of the hypopygium. Legs piceous, becoming blacker on the tibiæ and tarsi, bristly. The bristles on the somewhat swollen fore femora rather long and erect. Wings smoky, somewhat opaque, immaculate; costal bristles prominent, third and fourth veins parallel, the latter ending in the tip of the wing and with its proximal segment distinctly incrassated. The posterior cross-vein is very oblique, so that it forms an obtuse angle with the fourth vein. It is more than twice as long as its distance from the posterior margin. Halteres piceous. Tegular cilia black.

*Female*.—Length of body 2 mm.; length of wing 2.5 mm. The face is somewhat broader than that of the male, the proximal segment of the fourth longitudinal vein is not incrassated, and the bristles on the fore femora are not so prominent. The hairs on the last segment of the abdomen are long and prominent. The ovipositor is piceous.

Of this, the smallest and rarest of the Californian species of *Aphrosylus*, I have taken only three specimens, one male and two females. These were captured, together with specimens of *A. prædator*, at Pacific Grove, August 5th. More material is needed before it can be definitely affirmed that the proximal incrassation of the fourth vein is a male character and not an individual variation.

THE LARVA OF *APHROSYLUS*.

## PLATE IV, FIG. 14.

While observing the flies above described, it occurred to me that their larval and pupal stages might be passed in the salt water. A search for Dipteran larvæ in the tufts of algæ on the rocks was rewarded by finding several forms, some of which evidently belong to Nematocerous families. Two specimens, however, measuring 3.5 and 5 mm. respectively, taken at Pacific Grove during July, are undoubtedly Dolichopodid larvæ, and I did not hesitate to assign them to *Aphrosylus*. They are very probably the larvæ of the commonest species, *A. prædator*. My friend, Dr. H. P. Johnson, has recently given me another specimen, measuring 5.5 mm., taken in the same locality during December last.

These larvæ have the general characters that have been noted for the Dolichopodidæ by Beling, who has described the larvæ of six genera of this family (*Psilopus*, *Neurigona*, *Argyra*, *Porphyrops*, *Systemus*, and *Dolichopus*)<sup>1</sup>. They are glistening white, tapering to a point anteriorly, and less rapidly to the truncated posterior end, which is surrounded by nine flattened lobes. These are arranged as follows: One small lobe in the mid-dorsal line, two larger and dorso-lateral, one on either side, two ventral, largest of all and projecting furthest backward, and, between the dorso-lateral and ventral lobe on either side of the body, two small lateral lobes. The dorso-lateral and ventral lobes are each provided with two fan-shaped tufts of small bristles at their tips. The posterior tracheal openings lie one on either side at the inner bases of the dorso-lateral

<sup>1</sup> Beitrag zur Metamorphose der zweiflügeligen Insecten. Archiv f. Naturg., Jahrg. 41, Bd. 1, 1875, pp. 31-57; and Beitrag zur Metamorphose zweiflügeliger Insecten aus den Familien Tabanidæ, Leptidæ, Asilidæ, Empidæ, Dolichopodidæ, und Syrphidæ. Archiv f. Naturg., Jahrg. 48, Bd. 1, 1882, pp. 187-240. Other species are described by Brauer: Die Zweiflügler des k. k. Museums zu Wien. 3. Systematische Studien auf Grundlage der Dipteren-Larven nebst einer Zusammenstellung von Beispielen aus der Literatur über dieselben und Beschreibung neuer Formen. Denkschr. Akad. Wien. Bd. 47, 1883, pp. 19, 29-30, Taf. IV, figs. 72-75. This work also contains references to papers by v. Vollenhoven, Brown, and Smith, on the larvæ of *Macherium maritimum*. I have not had access to the contributions of these three authors.

lobes. There are twelve well marked segments in the body, and the fifth to eleventh of these, inclusive, have crenulated creeping-pads on their ventral surfaces. There are rudiments of antennæ on the first segment, and powerful jaws, each of which is toothed and connected posteriorly with a pair of delicate chitinous rods that extend back into the third segment. Between the ventral and somewhat shorter pair of these rods lies a curved unpaired chitinous element, the function of which is not clear. Anteriorly the tracheæ open on the second segment.

The four large lobes at the posterior end have been seen in other Dolichopodid larvæ. They are noted by Beling as occurring in all the forms he examined except *Neurigona*. This genus seems to have no such processes, and is described as “am Ende kuppelfoermig gerundet.” An unpaired dorsal lobe occurs in *Argyra*. The two pairs of small lateral lobes seem to be peculiar to *Aphrosylus*, unless they occur in the larva of *Machærium*, a description of which I have not seen.

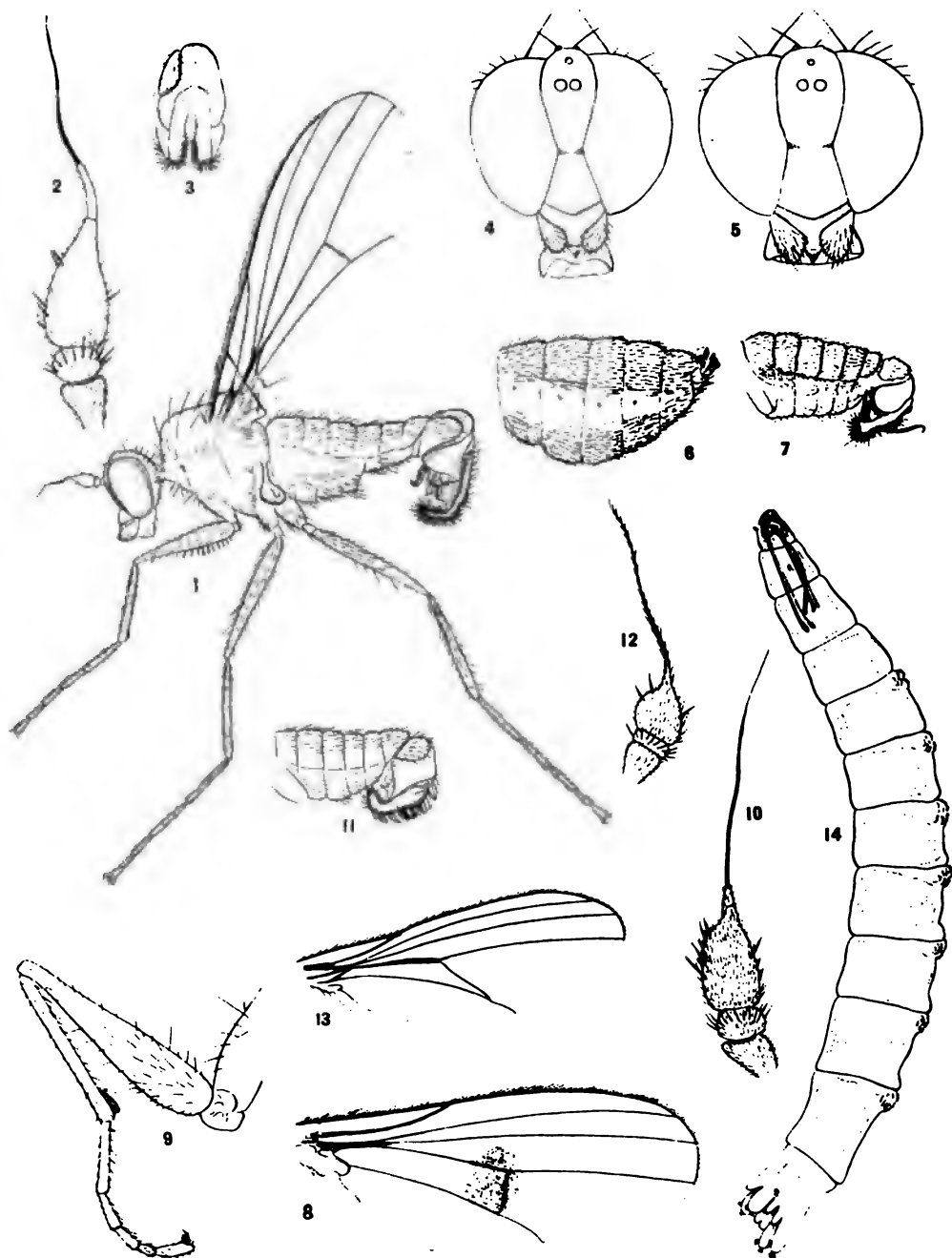
UNIVERSITY OF CHICAGO,

May 1, 1897.

## DESCRIPTION OF THE FIGURES.

- Fig. 1. *Aphrosylus prædator*. Male.
- Fig. 2. Antenna of *A. prædator*.
- Fig. 3. Hypopygium of *A. prædator* seen from behind.
- Fig. 4. Face of male *A. prædator*.
- Fig. 5. Face of female *A. prædator*.
- Fig. 6. Abdomen of female *A. prædator*.
- Fig. 7. Abdomen of male *A. direptor*.
- Fig. 8. Wing of *A. direptor*.
- Fig. 9. Fore leg of *A. direptor*.
- Fig. 10. Antenna of *A. direptor*.
- Fig. 11. Abdomen of male *A. grassator*.
- Fig. 12. Antenna of *A. grassator*.
- Fig. 13. Wing of *A. grassator*.
- Fig. 14. Full-grown larva of *Aphrosylus*.





APHROSYLUS.



PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES

ZOOLOGY.                      THIRD SERIES.                      VOL. I, No. 5.

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A Preliminary Account of the Marine  
Annelids of the Pacific Coast, with  
Descriptions of New Species.


BY

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*Assistant Professor of Zoology, University of California.*

WITH SIX PLATES.

*Issued December 11, 1897.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1897.





# A PRELIMINARY ACCOUNT OF THE MARINE ANNELIDS OF THE PACIFIC COAST, WITH DESCRIPTIONS OF NEW SPECIES.

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*Assistant Professor of Zoology, University of California.*

PLATES V-X.

## PART I. THE EUPHROSYNIDÆ, AMPHINOMIDÆ, PALMY- RIDÆ, POLYNOIDÆ, AND SIGALIONIDÆ.

THE marine Annelids of the western sea-board of our country have received but little attention, and by far the greater number of the species remain unknown to science. Any work done upon this group in this region, even at this late day, must necessarily have the character and limitations of pioneer work. It is certainly an interesting revelation of the haphazard nature of zoological exploration to find that much more is known about the Polychæta in the most remote regions of the earth, in the farthest north and the farthest south, in the East Indies and the South Seas, than along the easily accessible shore of a great civilized nation. No apology, therefore, need be offered for the preponderance of attention here given to such preliminary matters as descriptions of new species, distribution, habits, and other details of the natural history of the group. It is the writer's intention to present the entire order Polychæta, as represented on our shores, thus in outline, and concurrently or subsequently to fill in the picture with as much of embryological and histological detail as possible. The present publication is in every sense a *prodromus* of a more extensive work, which will require many years to complete.

Notices of marine Annelids of the Pacific Coast have been few and meager. The earliest collection of Annelids

from California was that of Kinberg<sup>1</sup>, who, sometime between 1851 and 1853, obtained a few specimens in the vicinity of San Francisco. Three species were described by Kinberg: *Halosydna brevisetosa* (which I have found in great abundance), *Mastigonereis spinosa*, and *Syllis californica*.

A much larger collection was gathered in 1859-60 by Alexander Agassiz, at several points along this coast between Panama and the Gulf of Georgia. Several new species were described from this material by Ernst Ehlers in his fine monograph "Die Borstenwürmer" (1864-67). This collection has never been entirely worked up.<sup>2</sup> It is worthy of note that three Atlantic species are enumerated in the list of Agassiz's Annelids—*Polynoë* (*Lepidonotus*) *squamata*, *Harmothoë imbricata*, and *Arenicola antillensis*. The occurrence of the two former on our coast I can verify from personal observation.

In 1863<sup>3</sup> and again in 1865<sup>4</sup> William Baird of the British Museum described seven species of Polychæta collected by J. K. Lord at Esquimalt, Vancouver Island. Four of these I have been able to identify with reasonable certainty: *Halosydna insignis*, *H. grubei* (both of them varieties of *H. brevisetosa* Kinberg), *H. lordi*, and *H. fragilis*,—and I strongly suspect that his *Harmothoë unicolor* is none other than the ubiquitous and highly variable *Harmothoë imbricata*. Baird's descriptions are lacking in precision, and are unaccompanied by figures.

Three species of Polychæta from our coast were described in 1889 by J. Walter Fewkes.<sup>5</sup> Two of these, *Sabellaria californica* and *Sabellu pacifica* are very common colony-forming species along the California coast.

<sup>1</sup> J. G. H. Kinberg: Nya Släkten och arter af Annelider. Öfversigt K. Vetensk.-Akad. Förh., Bd. XII, 1855; also in: Ibid, Bd. XXII, 1866 (Annulata Nova); also in: Frigatten Eugenies Resa omkring jorden, Zoölogi, 1858.

<sup>2</sup> I am indebted to my friend, Dr. Wm. M. Woodworth, for opportunity to copy that portion of his MS. catalogue of the Vermes of the Museum of Comparative Zoology which includes Prof. Agassiz's collection.

<sup>3</sup> Proc. Zool. Soc. (London) for Apr., 1863, pp. 106-110.

<sup>4</sup> Journal Linnæan Soc. (London), Vol. VIII, pp. 188-192, 196.

<sup>5</sup> "New Invertebrata from the Coast of California," Bull. Essex Institute, Vol. XXI, pp. 99-146, 7 Pls.

The material upon which my own study of the Polychæta is based has been gathered almost entirely from the California coast, and for the most part within the littoral zone. A few species not found within the area left bare by the tides have been dredged from very moderate depths (down to twenty or twenty-five fathoms), and a yet smaller number have been taken from stones brought up on fish-hooks from a greater depth in Monterey Bay.<sup>1</sup> The Polychæta now deposited in the Museum of the University of California have been collected by my colleague, Prof. Wm. E. Ritter, by students in the University (particularly Messrs. F. W. Bancroft and H. B. Torrey), and by myself. The localities where the most extensive and thorough collecting has been done are San Pedro (summer and winter of 1895, summer of 1896), Pacific Grove (1894, 1896, 1897), and the vicinity of San Francisco. Collecting has been done, besides, at a number of other points—San Diego, San Clemente and Santa Catalina Islands, Bodega Bay, Point Arena, Point Mendocino, Humboldt Bay, Shelter Cove, Trinidad, and Patrick's Point. A few species from Puget Sound have been recently added to the collection.<sup>2</sup>

A word should perhaps be said in regard to terminology. I have employed the old terms "dorsal" and "ventral" instead of the more modern "hæmal" and "neural." Consequently the uppermost branch or division of the parapodium is the "dorsal ramus," and the lower the "ventral ramus." The setæ borne by these two portions are respectively the "dorsal setæ" and the "ventral setæ." The appendages of the prostomium are the "tentacle" (median and unpaired), the "antennæ" (paired and adjacent to the tentacle) and the "palpi" (paired organs of touch, very contractile in Polynoidæ, springing from the ventral side of the prostomium). The somite immediately back of the prostomium is the "peristomium," and is the

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<sup>1</sup> For these specimens I am indebted to Dr. Bashford Dean of Columbia University. He was informed by Ah Tak, the Chinese fisherman from whom he obtained them, that the depth was 90 to 100 fathoms.

<sup>2</sup> For these I am indebted to Miss Alice Robertson, student in Natural Science at this University, and to Master John Dewhurst of Seattle, Washington.

first counted in an enumeration of the somites. Next to the prostomium, this somite is the most modified. Its cirri are the "peristomial" cirri, and are two, four, or eight in number. When two only are present, as in *Heteropale bellis*, they are the dorsal. A dorsal and ventral peristomial cirrus is present on each side in the Polynoidæ. In *Chrysopetalum*, where two pairs are present on each side, the duplication probably does not indicate the fusion of two peristomial somites, but a sort of chorisism or division of an original single pair. The "buccal" cirri are the much-enlarged ventral cirri of the second somite. The "anal" cirri are always a single pair belonging to the terminal or anal somite, which is invariably postanal in Euphrosynidæ, Aphroditidæ and Polynoidæ. The "nephridial papillæ" of the Polynoidæ and Sigalionidæ are the little protuberances on the ventral side, one at the base of each parapod for the greater portion of the animal's length. At their distal ends the nephridia open.

Descriptions and measurements have been based almost entirely upon specimens carefully preserved either in alcohol or formalin. Only in respect to color have I found any advantage in drawing up descriptions from living specimens; and there are positive objections to taking measurements from the living worms. While I have constantly endeavored to preserve specimens in a straight and extended condition, I am bound to say that my efforts have been only partially successful. No matter how gradual or prolonged the narcosis, very few species fail to undergo more or less contraction when placed in the fixing fluid. Since measurements taken from straight and moderately contracted specimens give quite as accurate an idea of the true dimensions of the species as if obtained from living worms, exhibiting as they usually do every gradation of extension and flexion; and since, furthermore, nearly all Annelid measurements extant have been made upon alcoholic material, I have seldom taken the trouble to get the dimensions of living specimens.

I gladly avail myself of this opportunity to express my



sincere and heartfelt thanks for the many courtesies extended to me by the directors of the Hopkins Seaside Laboratory at Pacific Grove, where I have on several occasions occupied an investigator's room, and enjoyed conveniences and advantages for marine zoological work elsewhere unknown on our coast.

## Family I. EUPHROSYNIDÆ.

### *Euphrosyne aurantiaca*, sp. nov.

PLATE V, FIGS. 1-4.

Form elongate-elliptical, slightly tapering at both ends, which are very uniform. Dorsal and ventral contours both convex, the ventral more so than the dorsal. Medio-dorsal bare stripe very narrow (1-1.5 mm.), not more than one-fifth the width of the body.<sup>1</sup>

Number of somites, 30-37. Buccal somites, first to fifth inclusive. Width of middle somites,  $5\frac{1}{2}$  times their length.

Caruncle bilobed dorsoventrally. Lobes coalesced the whole length of the shorter, inferior lobe, which reaches the anterior border of the fifth somite. The free posterior tip of the superior lobe extends back of this point about one-half the width of the fifth somite. The anterior edge of the caruncle carries a short, stumpy tentacle, at the base of which are located the single pair of dorsal eye-spots.

Prostomium not distinct from the caruncle, deeply sunken between the forwardly directed parapodia of the first somite. Ventrally, close to its anterior border, are the ventral eye-spots, flanked on each side by a minute antenna, which springs from the lateral edge of the prostomium.

Parapodia with three cirri, two dorsal, one ventral, and seven ramose "gills." Ventral cirrus inserted among the ventral setæ, gradually and evenly tapered from its base, about one-half the length of the ventral setæ. Lateral cirrus similar in form, placed between the third and fourth gills (counting from the dorsal extremity of the series). Dorsal cirrus stout, slightly swollen near base, evenly tapered, acute at tip, bent towards the median line. In contracted condition, none of the cirri are longer than the setæ among which they are placed.

"Branchiæ" bifid nearly to base; each branch carries 6 or 7 branchlets (fig. 1).

Setæ numerous on all the parapodia; those of the ventral series simply forked near tip; those of dorsal series deeply incised and curved at tip (figs. 2, 4), serrated on both sides of incision. All setæ are hollow to tip and impregnated with calcic carbonate, which gives them a glistening white appearance.

Color in life orange, darkest along mid-ventral line.

*Measurements*.—Length of average specimen, 21 mm; greatest breadth,

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<sup>1</sup>"Width of body" or transverse diameter in every case includes the parapodia, but not the setæ.

5.5 mm; length of caruncle, 2.5 mm. Length of largest specimen, 26 mm.; greatest breadth of same, 5.5 mm.

This species is common at San Pedro, from low-water mark to three or four fathoms, and probably to greater depths. It frequents shelly and stony bottoms. The enormous, matted rootstocks of the bladder kelp (*Macrocystis pyrifera*) afford it a welcome shelter. Many specimens were obtained from these rootstocks in July, 1895, when they washed ashore from San Pedro Bay, where the kelp grows to a depth of eight or nine fathoms.

The number of somites is variable, ranging, among twelve specimens, from 30 to 37<sup>1</sup>. The largest, measuring 26 mm. in length, had the largest number of somites, and the smallest, 16 mm. in length, had the least; but an increase in the number of somites as the size increases is by no means the rule.

All my specimens (with the exception of a single one dredged near Monterey from 12 fathoms) were obtained at San Pedro in July and August, 1895. None were taken there in December, 1895, although the same ground was dredged carefully. The larger individuals were sexually mature in July.

*E. aurantiaca* is most nearly allied to *E. myrtosa* Savigny, and to *E. mediterranea* Grube. It agrees with these in having: (1) seven pairs of gill-trunks, which are not extensively branched and have no end buds; (2) the caruncle extending to the fifth somite; (3) the number of segments. It differs in having: (1) setæ of two kinds; (2) the lateral-dorsal cirrus between the third and fourth gill-trunks, instead of between the second and third.

<sup>1</sup> The number of somites ran as follows.

37 somites . . . . .	2 specimens
36 " . . . . .	1 "
35 " . . . . .	1 "
34 " . . . . .	3 "
33 " . . . . .	1 "
32 " . . . . .	2 "
31 " . . . . .	1 "
30 " . . . . .	1 "

Average, 33%.

***Euphrosyne arctia*, sp. nov.**

PLATE V, FIGS. 5-7.

Smaller than the preceding; diminishing slightly at posterior extremity, nearly as broad at anterior end as at middle somite. Median bare stripe about one-fourth width of body.

Caruncle proportionally large and high, reaching posterior edge of fifth somite; slightly bilobed dorsoventrally, the two lobes of equal length. Median tentacle short, less than one-half the length of the caruncle, with filiform tip. Two eye-spots at its base.

Preoral pads large, completely fused, and in preserved specimen covering the ventral eye-spots. Mouth set far back, its posterior border formed by fifth somite. The prostomium bears near its ventro-anterior edge the two small tentacles, which are probably homologous with the antennæ of related forms.

Setæ of dorsal rami of two kinds: simple bifid and ringent (fig. 6); the latter longer and stouter than those of *E. aurantiaca*.

Ventral setæ more slender than first type of dorsal, which they resemble; dorsal with a smaller, more divergent spike (fig. 7. two sizes).

Five "branchiæ" on each side, dichotomously branched four times (fig. 5). Latero-dorsal cirrus between second and third branchial trunks.

Number of somites 22. Buccal somites 1-5. Colors in life ochraceous; rose-red on bare dorsal stripe; the setæ, as usual in this genus, silvery white.

A single specimen of this pretty little Annelid was brought up on a stone from a depth of about 100 fathoms in Monterey Bay, in July, 1896. This individual proved to be a female, and its body-cavity was crowded with nearly mature eggs.

This form comes nearest to *Euphrosyne armadillo* Sars. From Ehlers' brief diagnosis of *E. armadillo*, in the "Borstenwürmer," I am unable to determine whether the Californian species is identical with the Norwegian. I have not seen Sars' description of the latter and must therefore defer passing judgment upon the specific distinctness of *E. arctia*.

**Family II. AMPHINOMIDÆ.*****Eurythoë californica*, sp. nov.**

PLATE V, FIGS. 8-14.

Body long and rather slender, gradually tapered in its posterior third. Anterior end very slightly tapered; head about one-half the greatest diameter of the body. Cross-section of body squarish, dorsum nearly flat (except when distended with the genital products); ventral contour decidedly convex, sides between the rami flat and vertical.

Segmentation strongly accentuated, breadth of segments (in alcoholic specimens) from two to three times their length.

Head abruptly narrowed to the hoof-shaped prostomium, which is convex above, but nearly flat beneath. On its ventral aspect is a slight longitudinal groove which extends backward to the mouth. The prostomium bears two pairs of cirri, a median cirrus or "tentacle," and two pairs of eyes; the dorsal pair in front of the anterior pair of eyes, and same distance apart as the latter; the ventral cirri further apart and in the same vertical plane as the anterior pair of eyes. There is little or no difference in the length of the paired cirri.

Eyes four, the anterior pair considerably larger and a little nearer together than the posterior; anterior pair placed in a transverse sulcus that divides the dorsal side of the prostomium into anterior and posterior portions. The posterior portion carries not only the four eyes, but also the tentacle, and extends caudad as the caruncle. Tentacle decidedly shorter than the paired cirri, tapered uniformly from the base, and very acutely pointed at tip.

Caruncle slender, cylindrical, flexuous, reaching anterior border of third somite.

Mouth triangular, the apex running forward as the median groove in the ventral side of prostomium; bordered posteriorly by the fourth somite, which forms a crenated and somewhat tumid lip.

Anus terminal, minute.

Parapodia (fig. 9) composed of two widely separated rami. The ventral ramus with a fascicle of long, slender setæ, of varying lengths, and a few short hastate ones (figs. 12-14). The long setæ have a slight lateral prong near tip; they are silvery white by reflected light. The dorsal setæ shorter than the longest of the ventral fascicle, and of various lengths and sizes. They fall under three types: (1) long, very slender, bifid setæ, almost precisely similar to the corresponding type of the ventral ramus (fig. 12); (2) long, stout, serrated setæ (fig. 10); and (3) short and very stout, smooth setæ (fig. 11), which probably correspond to the hastate setæ of the ventral ramus, but are much more numerous.

The dorsal ramus of every parapod, except the first, carries a ramose gill. The number of branches in each gill increases backward; the gills of the second somite are very simple, having only two or three branches. The maximum complexity is attained at about the twelfth somite.

Dorsal and ventral cirri present on all the somites, very similar in form, smooth, terete, jointed near base, evenly tapered to the small, rounded tip; shorter than the longest setæ of both fascicles; dorsal cirrus considerably longer than the gills.

Number of somites, 60-93.

Living color variable, flesh to dark brown. When sexually mature the eggs shine through the body-wall and give the female a decided purple tinge, while the ripe males are red. A beautiful purple and green iridescence on ventral side.

*Measurements.*—Length of full-grown specimen, 106 mm.; width, 5 mm.; dorsoventral thickness, 3 mm. Length of smallest specimen (60 somites), 22 mm.; caruncle, 1 mm. long; average length of middle somites, 1.5 mm.

*Habitat*.—San Pedro sand-flats, between tide-marks, (July and December). Rocky shores at Pacific Grove, near low-water mark (December).

This species differs from *Eurythoë pacifica* Kinberg and from its variety *levukaënsis* M'Intosh in the following points:

(1) The body is more slender; (2) the tentacle is placed between the posterior instead of the anterior pair of eyes; (3) the caruncle is much narrower, and extends only to the third somite, instead of to the fourth. The bifid setæ are likewise different in lacking the serrations near the tip.

It is evidently distinct from *Eurythoë complanata* Pallas which, as its name indicates, is much flattened dorsoventrally, while in *E. californica* the vertical and horizontal diameters are nearly equal. A further distinction is seen in the tentacle, which is much shorter in *E. complanata* than in *E. californica*.

### Family III. PALMYRIDÆ.

#### *Chrysopetalum occidentale*, sp. nov.

PLATE V, FIGS. 15, 16; PLATE VI, FIGS 17-19.

Form elongate, scarcely tapered anteriorly, and but little posteriorly, slightly flattened dorsoventrally; segmentation clearly marked, prostomium and parapodia prominent and distinct. Mouth set far back, bordered posteriorly by fifth somite.

Prostomium rounded above, its breadth greater than its length, bearing the four eyes, of which the anterior pair are nearer together than the posterior, and are sometimes fused into a large black patch. On its antero-ventral aspect the prostomium carries the median cirrus, two antennæ, and the palpi (fig. 15). The median cirrus is less than half the length of the antennæ, stout, conical, indistinctly jointed near its base. Antennæ swollen in their proximal half, contracted at point of attachment, gradually tapered, their distal half, like that of all the cirri, roughened with scattered spinulations. Palpi short, decidedly less than antennæ, thick, very slightly tapered, bluntly rounded at tips, constricted at base.

First somite bears on each side two pairs of peristomial cirri, not essentially different from the rest of the dorsal and ventral cirri, each two jointed; three on each side nearly equal in length, but ventral cirrus of posterior pair decidedly shorter (Pl. V, fig. 16).

Second somite setigerous, with distinct, anteriorly directed parapodia, extending in front of prostomium. Dorsal setæ, like those of all succeeding

somites, in the exceedingly modified form of paleæ. Ventral setæ about thirty in each fascicle, compound, with cultrate appendage (Pl. VI, figs. 17, 19), the latter hooked at tip, finely spinulose on its straight border. Medulla of shaft cross-striated, forked at point of articulation with appendage.

Paleæ on all somites except peristomial and anal; they are of two sizes: (1) a lateral group of three to five narrow ones, extending at right angles to long axis of body; (2) a circlet of twenty or more, considerably broader and longer (Pl. VI, fig. 18), lying dorsally, and covering the succeeding somite like a thatch of palm leaves. Paleæ of different somites vary in width. Those of the second much narrower than the rest, and like the lateral groups. All, however, are constructed after one pattern. An average one is shown in fig. 18. It is curved in two planes; upper surface concave, the upcurved edges serrate and slightly involute, tip curved towards median line of animal, acute. Seven to eight longitudinal ribs, and numerous, fine, parallel, transverse striations. All paleæ have a golden-brown luster.

Parapodia with dorsal and ventral aciculæ (fig. 17), the ventral nearly three times the length of the dorsal. Ventral ramus long and slender; dorsal ramus a slight, rounded, broad protuberance. Both dorsal and ventral cirri jointed, terminal portions very similar in form, subulate.

Approximate number of somites in two specimens, 55 and 41. Buccal somites, first to fifth.

*Measurements*.—Length, 4.57 mm.; width across broadest part of body, .79 mm.

*Habitat*.—San Pedro Harbor, California (15 feet).

This little Palmyrid was found but once, in small numbers, in December, 1895. Like the type species, *C. fragile* Ehlers, it is notable for the readiness with which it breaks transversely. In a preserved specimen the individual somites may be readily detached, one after the other, from the trunk. The related species of our coast, *Heteropale bellis*, has the same characteristic.

This form shows numerous points of difference from *C. fragile* in the shape of the paleæ, of the setæ, of the dorsal cirri, and of the eyes. I have had no opportunity to compare it with the description of *C. debile* (Grube) Ehlers.

### **Heteropale, gen. nov.<sup>1</sup>**

Preoral lobe not distinct externally from peristomium. Palpi present. Eyes four, tetragonal in arrangement. Tentacle unjointed, about equal to antennæ. Antennæ two, each composed of a long basal piece and a small terminal segment. Dorsal peristomial cirri two, similar to antennæ. No

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<sup>1</sup> From ζτερος, varied, and παλῆ, palea.

ventral peristomial cirri. Parapodia biramous. Dorsal ramus with two kinds of paleæ: (1) a group of small, narrow ones projecting laterally (figs. 21, 22a); and (2) a crown of broad, oblanceolate ones on the dorsum. Aciculæ two. Dorsal cirri present on all somites, three to many-jointed, proximal joint much the largest. Ventral cirri very short, inserted above the level of lowest ventral setæ.

### *Heteropale bellis*, sp. nov.

#### PLATE VI, FIGS. 20-23.

Body elongate-elliptical, slightly and about equally tapered at each end, its length less than six times its width.

Prostomium rounded, coalesced with first somite. Eyes four, forming a square on top of head; the anterior pair considerably larger, crescent-shaped. Median cirrus or "tentacle" unjointed, up-curved in a hook-like fashion, in length equal to the antennæ.

Two globular palpi, somewhat constricted at base. Antennæ two, two-jointed; tentacular cirri two, three-jointed, about equal to the antennæ, short and stumpy, the proximal joint about equal to the two terminal ones. Dorsal cirri present on all the somites, increasing in length and number of joints caudal until in the ultimate segments they reach nearly to the tips of the setæ. In the anterior somites they do not reach the tip of the neuropodium and have only three joints. Ventral cirri likewise increase in length and number of joints caudal, but in less degree.

First pair of parapodia directed forward, armed with a small fascicle of setæ and three or four paleæ. No obvious dorsal ramus. Succeeding parapodia with a two-parted dorsal ramus. Its lateral division, nearly as long as the ventral ramus, carries three or four paleæ much narrower, smaller, and straighter than the rest; these point laterally in line with the ventral rami (fig. 21). The acicula extends into this division. Dorsal portion of notopodium with a semicircle of paleæ, thirteen or fourteen in number, the largest external, and diminishing towards the median line. Oblanceolate, acuminate; tip directed obliquely, mediad or laterad (fig. 22); convex border of palea and seven or eight of its ribs elegantly adorned with minute, rounded embossments. Other ornamentation in form of longitudinal ribs and fine transverse striations. The paleæ of each somite overlap those of the succeeding somite, and over- or underlap the tips of their fellows on the foot of the opposite side.

Somites, 27 to 39. Terminal somite destitute of paleæ and setæ, but with two anal cirri.

*Measurements.*—Length of small specimen, 2.75 mm.; greatest transverse diameter of same, .44 mm.

Two specimens found among tunicates, sea-weeds, and *débris* on the piles of the wharf at Monterey, December 23, 1896.

Not without reluctance I have made this beautiful little Annelid the type of a new genus. It differs strikingly from all

known Palmyrids in the heterogeneous character of its paleæ, and in the possession of only one tentacular cirrus (the dorsal) on each side. Minor points of difference from *Chrysopetalum* are the multi-segmented, almost moniliform character of the cirri, and the unusual position of the ventral cirrus (fig. 21). The ventral setæ are very similar to those of *C. occidentale* (cf. figs. 19a, b, and 23a, b.)

The golden luster which is so beautiful a feature of the paleæ in most Palmyrids is not conspicuous in this species.

#### Family IV. POLYNOIDÆ.

At least twelve representatives of this large family have been obtained from our western coast, between Bering Straits and the Mexican boundary line. Ten species have been collected by me and are here described. The remaining two, *Polynoë vittata* and *P. tula*, were described by Grube<sup>1</sup> in 1855 from material obtained at Sitka. I have not seen his descriptions. *Halosydna insignis* and *H. grubei* described by Baird in 1863<sup>2</sup> and again in 1865<sup>3</sup> from specimens collected by J. K. Lord at Esquimalt, Vancouver Island, are merely varieties of one species and identical with *Halosydna brevisetosa*, described by Kinberg<sup>4</sup> eight years previously. *Harmothoë unicolor*, described by Baird from the same locality as the two preceding, is probably a variety of *H. imbricata*.

The classification of the Polynoids is in a most unsatisfactory state, and much in need of thorough revision. The great multiplication of genera, nearly all of them founded upon variable, non-essential, or even accidental characters, and none of them clearly and fully defined, has been a serious drawback to the study of these interesting forms. Hence the more conservative students of the group, recognizing the instability of the numerous genera

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<sup>1</sup> Beschreibung neuer oder wenig gekannter Anneliden. Arch. für Naturgesch., Bd. XXXI, 1855, p. 1.

<sup>2</sup> 1. c., p. 106, 107.

<sup>3</sup> 1. c., p. 188, 189.

<sup>4</sup> 1. c., p. 385.



founded by Kinberg, Malmgren, M'Intosh, and others, have been content to place all new Polynoids under the type genus, *Polynoë*. This prudent course I have been strongly inclined to follow, fully realizing the rashness of attempting to revise a classification without access to the amplest material. But after a careful study of the few species at my command, and of the best part of the Annelid literature, I have become strongly convinced of the practicability of ranging nearly all the known Polynoids under two genera. Following are diagnoses of these genera. I would have it clearly understood, however, that I do not consider this anything more than a provisional attempt to improve and make manageable a classification which is a positive hindrance to the study of this group.

***Polynoë Savigny (Sens. ext.).***

Prostomium bilobed, the anterior tips of the lobes produced to form basal joints of the antennæ, which are on the same level as the basal joint of the tentacle. Dorsal rami of the parapodia decidedly smaller than the ventral, often minute, bearing setæ more slender than the ventral setæ, sometimes very minute, few, or even wanting. Ventral ramus much the larger and longer, bearing a moderate number of setæ, which are stouter and usually longer than those of dorsal ramus. The dorsal and ventral rami not prolonged in a finger-like process beyond the insertion of the setæ. Elytra from 12 to over 50 pairs. Body sometimes excessively long; somites 27 to 100 or more.

In this genus I include *Lepidonotus* Leach, *Polynoë* Savigny, and *Halosydna* Kinberg.

***Harmothoë Kinberg (Sens. ext.).***

Prostomium bilobed, prolonged in front in two acuminate or rounded peaks. Antennæ inserted below level of tentacle. Both rami of parapodia prolonged in a finger-like process beyond the insertion of the setæ. Dorsal setæ as large or larger than the ventral setæ, never extremely short, often longer than the ventral. Both dorsal and ventral setæ serrated for more than half their exposed length. Body never excessively long; somites not exceeding forty; elytra, twelve to fifteen pairs.

Under this genus I would place the following: *Antinoë*, *Harmothoë*, *Hermadion*, Kinberg; *Eucrante*, *Eunoa*,

*Evarne*, *Lænilla*, *Lagisca*, *Melænis*, *Nychia*, Malmgren;  
*Polyeunoa* M'Intosh.

Owing to lack of full and accurate descriptions, and especially figures, of the remaining genera of the family, I am unable to state how many more can be consistently characterized as *Polynoë* or *Harmothoë* in the wide sense.

***Polynoë squamata* (L.) Aud. et M.-Edw.**

PLATE VII, FIG. 30.

The occurrence of this North Atlantic and Arctic species on this coast was quite unexpected, inasmuch as it does not appear to be so widely distributed, or to occur in such high latitudes as the ubiquitous *Harmothoë imbricata*. I believe it has not hitherto been reported from the Pacific, or indeed from the western portions of the Arctic.<sup>1</sup>

It is by no means a common species on the California coast, and, as far as my observation goes, does not occur within the littoral zone. The nine specimens at my command were all obtained in Monterey Bay; some dredged in twelve fathoms on stony ground, others brought up on stones by a Chinese fisherman from a depth of 90 to 100 fathoms.

I find nothing in the external anatomy of these specimens that would justify specific distinction from *P. squamata*. They are all much smaller than the general run of Atlantic specimens (the largest measure only 16 mm. in length), but otherwise it is difficult to find even varietal difference between them and specimens of typical *P. squamata* from the New England coast.

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<sup>1</sup>This species is entered in Dr. Woodworth's catalogue of Prof. Alex. Agassiz's collection from this coast, as having been obtained from the Gulf of Georgia. Nothing has been published concerning it.

*Polynöë brevisetosa* (Kinberg).

PLATE VI, FIG. 24; PLATE VII, FIGS. 31, 40, 40a; PLATE VIII, FIGS. 46, 46a.

*Halosydna brevisetosa* KINBERG. Ofversigt K. Vetenskaps Akad.

Förh., Bd. XII, 1855, p. 385.

Ibid, Fregatten Eugénies Resa, Zoologi, 1858, p. 18, Taf. V, figs. 25 a-h.

*Lepidonotus insignis* BAIRD. Proc. Zool. Soc. (London), Apr., 1863, p. 106.*Lepidonotus grubei*. Ibid, p. 107.*Halosydna insignis* BAIRD. Journ. Linn. Soc. (London), Zool., Vol. VIII, 1865, p. 188.*Halosydna grubei*. Ibid, p. 189.

Form variable, from short and robust to rather long and slender (the latter always commensal in tubes of Annelids), about equally rounded at both ends. Somites 37; elytra, 18 pairs, borne on somites 2, 4, 5, 7 . . . 27, 28, 30, 31, 33. Elytra seldom covering the entire dorsum, frequently many of them not in contact with one another. Anus exposed, dorsal, in somite 35, or between 35 and 36.

Prostomium (fig. 31) as broad as long, slightly constricted at base, broadest a little back of anterior pair of eyes, slightly fissured longitudinally at insertion of basal joint of tentacle. Eyes four, far back, and distant transversely, anterior pair slightly farther apart than the posterior.

Antennæ, tentacle, peristomial, dorsal, and anal cirri all of moderate length, smooth, cylindrical, slightly bulbous near tip, abruptly tapered to a filamentous point. All these cirri characterised by a dark subterminal band, just below bulbous enlargement, strongly contrasting with the white apex; and a dusky area, above the joint. (This coloration of the cirri holds for all color-varieties of the species, except in case of the antennæ and tentacle, which are frequently dusky for their entire length as far as the subterminal band.)

Palpi whitish, unpigmented, except in very dark specimens, thickest near base, very gradually tapering to a fine point, beset with minute papillæ, extremely contractile, being about thrice the length of the tentacle when fully extended, but contracting to about one and a half times its length.

Parapodia (fig. 46) stout, short, scarcely biramous; dorsal ramus very small, provided with short, minute, serrated setæ, not reaching beyond tip of ventral ramus. Ventral ramus obliquely truncated, robust, armed with about sixteen setæ in two groups, six above the acicula, ten below. Setæ rather short and stout, slightly hooked at tip, which is blunt, with about ten "frills" on their posterior aspect, largest distally (figs. 46, 46a). Ventral cirri on all the parapodia subulate, pointed, of same color as general ventral surface. Anal cirri not longer than average dorsal cirri.

Nephridial papillæ cylindrical, slightly fluted, begin at eighth somite, cease at thirty-fifth or thirty-sixth—28-29 pairs.

Elytra extremely varied, broadly reniform to elliptical, first pair nearly orbicular, with a few small, short "cilia" on external border (fig. 40); the first three or four pairs with large, rounded chitinous tubercles, the remainder with minute ones (figs. 40, 40a). Each elytron with an ocella consisting of a

white spot just over the elyrophore, with a black, gray, brown, or orange fleck in front; remainder of elytron more or less densely mottled with spots of the same color as the general pigmentation.

Coloration highly variable, but in all cases the fundamental or ground color is white. This is overlaid by pigmented areas of iron-gray, tawny, brown, yellow, or orange. Melanistic specimens are common, in which the iron-gray is intensified to almost jet black, and even the ventral side is dark.

Each somite marked dorsally with a transverse dark bar, in front of which is a lighter bar of the same color, broadly interrupted in the median line, and often broken transversely by a fine white stripe midway of its width. Ventral side either unpigmented or washed with ashy in melanistic individuals; this dark tint accentuated by a narrow, white, mid-ventral line.

*Measurements.*—Length of large commensals, 75 mm.; width across middle of body, 11 mm.; length of full-grown non-commensals, 57 mm.; width across middle of body, 9 mm.

This fine Polynoid is the commonest of its family along a large portion of our coast. I have obtained it in abundance between tide-marks at Pacific Grove and in the vicinity of San Francisco, both in the bay (at Lime Point and Point Cavallo on the northern side of the Golden Gate) and along the outer shore. I have also numerous specimens from localities further north—Point Arena, Cape Mendocino, Humboldt Bay, Trinidad, and Puget Sound. How much further north and south it extends I am unable to say, but have never found it at San Pedro or San Diego.<sup>1</sup> Undoubtedly it ranges much further northward than Puget Sound. I am confident that the species collected by J. K. Lord at Esquimalt and described by Baird under the names *Halosydna insignis* and *H. grubei* are varieties of this form.

I have never dredged this species, and am ignorant of its bathymetrical range. Northward, at any rate, it extends a good deal below low-water mark. I have specimens taken from the buoy at Point Arena, for which a depth of 15 fathoms is recorded; and others from Humboldt Bay, taken at a depth of 9½ fathoms.<sup>2</sup>

*Halosydna brevisetosa* is probably entitled to the distinction

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<sup>1</sup>A single specimen was collected by Mr. F. W. Bancroft at Avalon, Santa Catalina Island, in August, 1893. Avalon lies south of San Pedro about 25 miles from the mainland.

<sup>2</sup>These specimens were kindly presented to the University by Capt. Frank Curtis, United States Light House Inspector, along with other Invertebrata from the buoy-chains.

of being the first marine Annelid from the California coast described in any scientific work. A brief Latin diagnosis of the species was given by Kinberg in 1855<sup>1</sup> and a more ample description, with several fairly good figures, in the "Eugenies Resa" in 1858<sup>2</sup>.

In this second account Kinberg states that his specimens were obtained at "Sausalito Bay, near San Francisco, California, on the shore and at a depth of eight to ten fathoms."

Probably no species of this great family, noted for the morphologic plasticity of many of its members<sup>3</sup>, is more variable than this. The variation it exhibits is unquestionably due to differences in its environment. It is not only free-living under a variety of conditions (under stones, among tunicates, mussels, sea-weeds, etc.), but is also a common commensal in the tubes of species of *Amphitrite* and *Thelepus*. Like another tube-commensal of our coast, *Polynoë reticulata*, it attains a larger size in this mode of existence than when free-living, but not unless it lives in a tube of liberal dimensions, so that both the rightful occupant and its messmate have ample space. As with other species of the genus, there is a strong tendency for the commensal to attain a great length, and but slight proportionate diameter. This condition is probably seen at its maximum in *Polynoë ocellata* of Japan (commensal with the narrow-tubed *Spiochaetopterus challengeriae*), which, according to M'Intosh<sup>4</sup>, has over 100 somites, more than 50 pairs of elytra, measures 60 mm. in length, and only 2.5 mm. in width, including the setæ. Not alone are the commensal individuals of the present species longer and proportionately narrower than the free-living ones, but they exhibit other peculiarities. The elytra are thinner, smoother, sometimes destitute of any except microscopic tubercles, with few or no marginal "cilia," and not so likely to extend to the extreme posterior end of the body, reaching usually not further back than the anus. There is a marked tendency to develop a

<sup>1</sup>l. c., p. 385.

<sup>2</sup>l. c., p. 18, Taf. V, figs. 25 a-k.

<sup>3</sup>For an excellent account of the variability of *Polynoe squamata* and *P. clava*, see Bourne "Certain Points in the Anatomy of the Polynoina", Trans. Linn. Soc. (London) 2nd Ser., Zoology, Vol. II, pp. 347-356, Pls. XXXIV-XXXVI.

<sup>4</sup>Challenger Reports, Zoology, Vol. XII, p. 126, Pl. XII, fig. 3.

strong upper bristle in the ventral series—a characteristic very apparent, in *P. gigas*, even to the naked eye, and probably of advantage in crawling within the tube. An unlooked-for characteristic is the heavier pigmentation of commensals, and the more uniform distribution of pigment over the body. I have one specimen from Humboldt Bay which is almost entirely black, and has the largest and thinnest elytra I have ever observed in this species.

I have not detected a tendency in northern specimens to be larger than those from near the southern limit. Two specimens from Puget Sound, while of generous dimensions, do not equal the largest obtained at Pacific Grove.

### *Polynoë reticulata*, sp. nov.

PLATE VII, FIGS. 32, 41, 41a; PLATE VIII, FIGS. 47, 47a, 47b.

General aspect very nearly like *P. brevisetosa*. Form oblong-linear, tapering gradually and about equally at both extremities, broadest midway of its length. Somites 37; pairs of elytra 18, on somites 2, 4, 5, 7....27, 28, 30, 31, 33.

Prostomium (fig. 32) slightly longer than wide, deeply and broadly fissured longitudinally, globose, constricted at base; the basal joint of tentacle set into this fissure. Eyes four, anterior pair considerably wider apart than the posterior, just in front of widest region of prostomium, laterally directed. Posterior pair slightly smaller, near base of prostomium, dorsally placed.

Anus dorsal, in somite 35.

Elytra large, thin, orbicular (first pair) to irregularly reniform (fig. 41); all smooth except first two or three pairs, which have small conical tubercles (rarely these are present on all the elytra); sparingly ciliate on external margin. The elytra increase gradually in size from the first pair backward, and attain their maximum about the twelfth pair. The first pair are often scarcely half the diameter of the broadest. The upper surface of the elytron is closely punctate or pitted with little rounded or irregular cavities, between the orifices of which lie the epithelial cells, the latter forming a sort of reticulation or network (fig. 41a).

Parapodia (fig. 47) robust, biramous; dorsal ramus very small, with setæ of two sorts (fig. 47b): short, strongly curved ones, which are uppermost, and a small fascicle of long, slender, gently curving ones, which reach beyond the tip of the ventral ramus.

Ventral setæ toothed at tip (fig. 47a), serrated for a short distance below the point, rather short and stout.

Cirri smooth, slightly thickened below the point, gradually tapering. Anal cirri short, almost conical, not longer than posterior dorsal cirri. Antennæ inserted at level of base of tentacle, shorter than tentacle. Peristomial cirri not different from average dorsal setæ.

Palpi slightly thickened near the point, which is fine and filamentous; mi-

nutely papillated, pigmented nearly their entire length, darkest adjacent to the white tip.

Nephridial papillæ begin usually at eighth somite; sometimes as far back as the twelfth; end at thirty-fifth or thirty-sixth.

Colors never strong or bright, varying from reddish brown to ashy, gray, or drab, sometimes very pale. A small, darker spot on each elytron, frequently accompanied and accentuated by a light spot, as in *P. brevisetosa*. A double row of rectangular dark spots, often present on ventral side, segmentally arranged. Each dorsal cirrus, also tentacle, antennæ, peristomial cirri, and anal cirri, ringed with a dark band at or about the level of the thickened area. Dorsum transversely barred with alternate dark and light bands.

*Measurements*.—Large specimen: length, 48 mm.; greatest breadth, 7.25 mm.

The present species is distinctly southern in its range, occurring abundantly at San Pedro and at San Diego. I have found a few individuals at Pacific Grove, but invariably in the tubes of *Amphitrite* or *Thelepus*—never free-living. I have not found it further north.

The commensal habit is no more established in this species than in *P. brevisetosa*; both are facultative commensals, as far as the *species* is concerned, but probably not entirely so as regards *individuals*. The constancy of the commensalistic life throughout an individual existence is evinced both by the invariable commensalism of *P. reticulata* at the northern limit of its distribution, where it comes into competition with *P. brevisetosa*, and by the thorough-going modifications caused by this mode of life in the latter species.

Ecologically, *P. reticulata* almost exactly replaces *P. brevisetosa* beyond the southern limit of the latter, and the superficial resemblance of the two species is very strong. It fills the same place in nature, crawling over stones, nestling under them, or in the countless crevices among the multifarious vegetable and animal growths of the "littoral belt." Further than this, not a few individuals are found in the tubes—whether occupied by the rightful owner or not—of Terebellid worms, mainly species of *Amphitrite*, *Terebella*, and *Thelepus*. The commensal habit has by no means brought about such modifications in the present species as in *P. brevisetosa*. I have not found it easy to

make out just what the peculiarities of commensals are, they are so slight and indeterminate. Commensals are not, as in *P. brevisetosa*, decidedly more pigmented; but, on the contrary, are usually somewhat paler than the free-living individuals. The elytra are a trifle thinner and smoother. There is no special modification of the setæ, or of the body-form.

The largest and finest specimens have been collected at San Pedro, where the species is very abundant on rocky shores near low-water mark. It is probable that this portion of the California coast is its "metropolis," for the individuals obtained in San Diego Bay (where it occurs in some abundance on the piles) and at Pacific Grove are very much smaller than the general run of specimens from San Pedro. It should, however, be stated that most<sup>1</sup>, if not all, of the very large individuals collected at San Pedro were commensalistic in the tubes of a huge *Amphitrite* common in that region, but not found, so far as present knowledge goes, at San Diego or at Pacific Grove.

In addition to the localities above mentioned, this species has been collected by Mr. H. B. Torrey at Avalon, Santa Catalina Island, and on San Clemente Island.

At Pacific Grove the breeding season is evidently in the summer. A female collected there in July shed ripe eggs.

### ***Polynoë gigas*, sp. nov.**

PLATE VII, FIGS. 33, 42, 42a; PLATE VIII, FIGS. 48, 48a, 48b, 49.

Form much elongated, robust when fully grown, obtusely rounded at both ends. Young much more slender proportionally and gradually tapering from the middle to the posterior extremity.

Somites variable in number, usually between eighty and ninety; elytra likewise variable, forty to fifty pairs. Elytra not extending to posterior extremity. Anus conspicuous, at anterior edge of penultimate somite.

Prostomium (fig. 33) very broad, globose, median fissure slight, reaching not over half-way to base of prostomium. Eyes four, anterior pair situated at widest part of prostomium, much larger than posterior pair, which are nearer together. Antennæ attached at level of tentacle, articulated on anterior prolongations of cephalic lobe.

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<sup>1</sup> My notes are unfortunately defective on this point; but certainly a considerable proportion of the largest individuals were commensal with *Amphitrite*.



Cephalic cirri and dorsal cirri smooth, slightly thickened below the apex (the tentacle being the most so), ringed with black at the thickened place. The antennæ are decidedly shorter than the tentacle and peristomial cirri and about equal to the buccal cirri. Dorsal cirri, except the most posterior, of about equal length throughout, scarcely if at all surpassing the ventral setæ. Ventral cirri short, fusiform. Palpi very large, white or grayish, gradually and uniformly tapered from a thickened region near the base to the fine, filamentous tip. Minutely papillated all over, except at extreme base. Anal cirri extremely short, fusiform.

Parapodia very stout (fig. 48), much wrinkled near base. Dorsal ramus conical, diminutive, usually achætous, or with one or two minute setæ. One or two of the parapodia in posterior part of body usually asymmetrical, having an elytron on one side and a dorsal cirrus on the other (fig. 49).

Ventral setæ (fig. 48a) very large and stout, toothed near extremity, serrated for a short distance below the apex. Uppermost much the thickest, dark amber color (fig. 48b).

Elytra varying from irregularly reniform (fig. 42) anteriorly, to nearly orbicular along all the middle and posterior portions of the body. Smooth and entirely destitute of papillæ or tubercles. Ocellate, and mottled with blotches of iron-gray pigment, which is distributed in the epithelium of both sides of the elytron, as appears very distinctly when the elytron is viewed by transmitted light (fig. 42a).

Nephridial papillæ about twice as long as thick, enlarged at extremity, ringed with black. They extend from the eighth somite to the pygidial.

Colors dark-reddish on dorsum, iron-gray on elytra; each elytron with an imperfect ocellate spot; below, unpigmented. A dark spot at base of each dorsal cirrus; dorsal ramus dark.

A considerable portion of the dorsum is usually exposed in both young and old specimens.

*Measurements.*—Length, 165 mm.; width, 12 mm.

*Habitat.*—San Pedro, San Diego (Pt. Loma)<sup>1</sup>, commensal with large *Amphitrite*.

This magnificent Polynoid has been found only as a tube-commensal with a large species of *Amphitrite*, and is southern in its distribution. The dimensions above given are taken from alcoholic specimens which have undergone the usual amount of contraction. A fully extended, living specimen of the largest size would measure not less than 23 cm. Thus the present species ranks among the largest of its family and of its class.

It is worthy of note that the Polynoidæ of excessive

<sup>1</sup> We have obtained no specimens from San Diego Bay; but recently two were kindly collected for me (together with several other Polychætes from that region) by my friend Prof. Wm. M. Wheeler, at Point Loma, near the entrance to the Bay.

length are variable as to the number of somites, while those which have few somites are remarkably constant in this particular. I have never examined a specimen of *Polynoë brevisetosa* or *P. reticulata* that did not have 37 somites and 18 pairs of elytra; nor have I any specimen of *P. squamata* with more or less than 27 somites and 12 pairs of elytra<sup>1</sup>. It is very different with Polynoids possessing many somites; these follow the law of all elongated Annelids in having no fixed number of somites.

In the present species, for example, the number of somites in nine specimens of various sizes ranges from 81 to 86. The number of pairs of elytra in the same nine specimens varies from 41 to 47. But the most astonishing fact in regard to the elytra is the prevailing asymmetry of their arrangement. Out of the nine specimens examined, only three had the same number of elytra on the right and left sides, and, even among these three, two had each two asymmetrical somites, one elytraphorus on the right, the other on the left; so that even here the general symmetry was not real, but the simple result of balancing two asymmetrical somites. A dorsal cirrus is invariably present on the opposite side of the somite or somites bearing an extra elytron (fig. 49).

I can offer no explanation for this curious asymmetry<sup>2</sup>. Its very frequent, almost universal, occurrence precludes considering it a monstrosity. It is worthy of note, although not an explanation of the anomaly, that the extra elytron always occurs in the posterior region, where the arrangement of elytra is very different from that found further cephalad. As far as the thirty-third somite the sequence of the elytra is absolutely the same as in *P. brevisetosa*, *P. re-*

<sup>1</sup> The only exception I have noticed is *Harmothoe hirsuta*, which has 37 to 40 somites.

<sup>2</sup> The only other instance of such asymmetry among the Polynoidæ (or in fact among the Polychæta generally) that I have found any record of is *Lepidametria commensalis* Webster (H. E. Webster: "Annelida Chætopoda of the Virginian Coast," Trans. Albany Inst., Vol. IX, pp. 210, 211, 1879). This Polynoid is commensal with *Amphitrite ornata*; hence its mode of life is precisely like that of *P. gigas*. It is stated by Webster to have 38-50 elytra on a side, which "cannot be enumerated in pairs, since sides of the same segment may bear, one, an elytron, the other a dorsal cirrus. For the first 32 segments the arrangement is uniform. After the thirty-second segment, no two specimens present the same arrangement."

*ticulata*, and most, if not all, species having 18 pairs. Between the thirty-third and forty-ninth somites, the elytophorous and cirriferous somites alternate regularly. On somites 49 and 50 elytra are borne. From this point onward the arrangement differs in different individuals, but long series of elytophorous somites are the rule, alternating with pairs and trios of cirriferous somites. In one example the groups of elytophorous somites run as follows<sup>1</sup>:

Three.....	Somites 56-58
Five.....	" 61-65
Eight.....	" 68-75

In every instance I have found two long series of elytra-bearing somites at the posterior end; and it is in one or the other of these series that the extra elytron is found.

The replacement of an elytron by a dorsal cirrus on the opposite side of one and the same somite is no argument for the homology of these organs, as might at first seem to be the case. It is obvious that the mere *absence* of the elytron may be the determining factor leading to the development of the dorsal cirrus.

### Polynoë lordi (Baird).

PLATE VII, FIGS. 35, 44; PLATE VIII, FIGS. 51, 51a, 51b.

*Lepidomotus lordi* BAIRD. Proc. Zool. Soc. (London), April, 1863, p. 107.

*Halosydna lordi* BAIRD. Jour. Linn. Soc. (London), Vol. VIII, 1865, p. 190.

Body long and tapering gradually to the attenuated posterior extremity, thickest in anterior third from eighth to twentieth somite, slightly diminishing towards the head.

Prostomium (fig. 35) broader than long, bilobed, widest across posterior portion at level of anterior pair of eyes. Eyes four, of about equal size, posterior pair at extreme base of prostomium, nearer together than the anterior. Antennæ with joint at base, inserted slightly below level of basal joint of tentacle. Antennæ and tentacle short and stumpy, but with long filiform tips; slightly longer than prostomium.

Peristomial and dorsal cirri (fig. 51) short, fleshy, club-shaped, with long

<sup>1</sup> This specimen has 45 elytra on the right side, 44 on the left. The extra elytron of the right side occurs on somite 69. The enumeration above given is for the right side.

filiform tip; not longer than ventral rami with their setæ. Palpi in preserved specimens short, conical, pointed, with subterminal black zone.

Dorsum very broadly exposed between the elytra, which are unusually small, broadly reniform or orbicular, and either entirely immaculate or more rarely with a central black spot and flecks of black, or with a black border on posterior edge. Dorsum marked with numerous irregular, transverse bands, lines, and streaks of burnt sienna; the pigment massed in a broad, solid fillet on somites eight and nine. The rest of the body unpigmented.

Parapodia (fig. 51) small and numerous, short; dorsal ramus rudimentary, achæteous (or rarely with a few small setæ); ventral ramus stout, bearing two kinds of setæ: (1) a supra-acicular fascicle of blunt, slightly curved ones (fig. 51b); and (2) an infra-acicular series of hooked setæ (fig. 51a), similar to those of *P. pulchra* and *P. fragilis*; about 20 setæ in all. Ventral cirrus present, small and fusiform.

Number of somites, 67 to 74; elytra 31 to 35 pairs, extending to extreme posterior end of body.

*Measurements.*—Length of full grown specimen, 57 mm.; greatest width, 7 mm.

*Habitat.*—Northern portion of California Coast to Puget Sound. Commensal with *Glyphis aspera* and probably other Fissurellidæ, nestling under the mantle. Also with *Cryptochiton stelleri*, in the branchial groove.

I have a little hesitation in referring the species above-described to Baird's *Halosydna lordi*, although his description of the latter, based upon abundant material collected by J. K. Lord at Macaulay's Point, Vancouver Island, does not in all respects agree with the specimens at my command. For example, he describes the dorsal setæ as "stout, smooth, somewhat curved as they approach the point, enlarged and flattened and uncinatè at the point; those of ventral or lower division a little more slender, slightly enlarged near the point, which is straight, blunt, and striated across." My specimens are for the most part destitute of dorsal setæ, and have two different forms of setæ in the ventral ramus, neither of which agrees with Baird's description. The host mentioned by Baird is *Fissurella cratitia*. All my specimens from the Puget Sound region were in the mantle cavity of *Glyphis aspera*; those from Cape Mendocino are stated on the label to occur under the mantle of "*Fissurella*," but what species I do not know. Very probably these came from *Glyphis aspera*

also, as that is by far the commonest Fissurellid on that portion of the coast. I have collected a single specimen from the gill-groove of *Cryptochiton stelleri*, at Bolinas, Marin County, California. This is the only individual I have seen with black pigmentation on the elytra similar to *P. pulchra*.

***Polynoë pulchra*, sp. nov.**

PLATE VII, FIGS. 34, 43, 43a; PLATE VIII, FIGS. 50, 50a, 50b.

Form attenuated posteriorly, like *P. Lordi*, which this species closely resembles. Greatest width in anterior third, thence tapering gradually to slender posterior end.

Prostomium (fig. 34) broader than long, with two peculiar lateral expansions adjacent to peristomial somite. Eyes four, placed far back, those of each pair far apart, the anterior pair more distant than the posterior; posterior and anterior pairs of about equal size. The tentacle inserted about half the length of its basal segment into front edge of prostomium; slightly longer than prostomium. Antennæ prolonged from anterior tips of lateral lobes of prostomium, with distinct basal joints, about equal in total length to the tentacle. Palpi thick and fleshy, slightly tapered from base, abruptly at tip, ringed with black near their distal ends. Filamentous tips of all dorsal cirri protrude abruptly from the slightly thickened terminal portion.

Parapodia (fig. 50) long, dorsal ramus rather slender, enlarged distally, frequently achætatus, or bearing a few serrated and notched setæ (fig. 50b). Ventral ramus with a few (6-12) strong, amber-colored, hooked setæ (fig. 50a), which have a few very minute serrations on the thickened portion near the tip.

Dorsum usually exposed (but not broadly, as in *P. Lordi*) between the rows of elytra; transversely marked with brown bands, two to each somite. Elytra (fig. 43) slightly undulate at margin, broadly reniform, adorned with a black or dark brown spot over the elyrophore, and a narrow posterior border of the same color, or else immaculate; very smooth. Epithelial cells small (fig. 43a). Young specimens from *Holothuria californica* are amber-color, very translucent, and entirely unspotted. Older ones from the same host are suffused with Indian-red, often with a tinge of purple, and have a large central spot of brown on each elytron.

Number of somites, 48-64; pairs of elytra, 20-33. Elytra are borne on somites 2, 4, 5, 7....23, 26, 28, 29, 31....51.

*Measurements*.—Length, 51 mm.; greatest width, 10 mm.

This beautiful Polynoid occurs at Pacific Grove as a common messmate (or possibly parasite) of two animals wide apart in the organic scale: *Holothuria californica*

and the great key-hole limpet, *Lucapina crenulata*. In case of *Lucapina crenulata*, *Polynoë pulchra* nestles in the cavity between the mantle-flap and the foot; but in case of the holothurian, it clings to the surface of its host, and even at times crawls into its mouth. The hooked ventral setæ serve admirably to enable the animal to maintain its hold. In fact, it clings so closely one has to exercise care in removing a specimen or it will be ruptured. The animal will live a long time—how long I have not ascertained, but at least two weeks—after separation from its host, if the water be kept pure.

The astonishing variation of color which this species exhibits is in exact agreement with its varied mode of life. Under the mantle of *Lucapina* it is securely hidden from the observation of any inquisitive fish, and almost excluded from the light. In this situation it may either be destitute of pigment, or possess a color-pattern that would render it exceedingly conspicuous in almost any external environment. Nothing could be more chastely beautiful than the translucent cream-color, accentuated in the purity of its tint by the rich velvety brown of the dorsum and the jet-black of the elytra; and nothing could be more fatal to the creature if it were exposed to the attacks of predatory animals. It is not surprising, therefore, to find a different coloration in case of individuals that lead an exposed existence on the bodies of holothurians. In this instance the color of the parasite mimics that of its host. It is further interesting to note how slight a change is necessary in the pattern-coloration to render the animal inconspicuous. It is merely a washing over of the surface with reddish or brownish—the color of the holothurian. Then the spots are toned down to a lighter shade of brown, or from intense black to dark brown. The result is a very good color-mimicry of the holothurian.

The structure of the setæ in this species, in *P. lordi* and *P. fragilis*, is a beautiful adaptation to their ectoparasitic habit. The serrations are few and very diminutive; the tip is decidedly hooked, the number of setæ is reduced,

but they are increased in size; the dorsal setæ are frequently absent. The adaptation to the clinging function is closest where the animal is obliged to maintain its hold on the exterior of its host. So we find in *P. fragilis* and *P. pulchra* that the setæ are renewed as often as the tips become at all blunted; in these two species the nascent setæ can generally be seen after clearing with oil, within the ventral ramus of the foot (fig. 52). The setæ of *P. lordi*, on the contrary, are generally rather blunt at the tip. They may become so in this species without danger, inasmuch as the animal could maintain its place without clinging to its host.

*P. pulchra* has the habit of suddenly and forcibly extending the proboscis, which is sufficiently prehensile to enable the animal to lay hold of its host. When two or three of the worms are placed in the same dish they will often seize hold of one another with such violence as to detach one or more elytra from the region struck by the tip of the proboscis.

### **Polynoë fragilis (Baird).**

PLATE VII, FIGS. 36, 45; PLATE VIII, FIGS. 52, 52a, 52b.

*Lepidomotus fragilis* BAIRD. Proc. Zool. Soc. (London), April, 1863, p. 108.

*Halosydna fragilis* BAIRD. Journ. Linn. Soc. (London), Vol. VIII, 1865, p. 191.

Form of body almost precisely like that of *P. lordi*, but a trifle broader proportionately in the anterior third, and not so thick dorsoventrally. Elytra continuing to extreme posterior end, which is much attenuated. Segmentation strongly marked, elyrophores and pseudo-elytrophores (on cirrus-bearing somites) very prominent.

Prostomium (fig. 36) short, rounded, broader than long; longitudinal fissure continued to base; tentacle inserted in a deep notch anteriorly. All cirri thick and fleshy, much clubbed at ends, very abruptly reduced to a terminal filament. Antennæ very short, not exceeding length of prostomium, two-jointed, joints of nearly equal length. Palpi short, acutely pointed, with subterminal dark ring. Eyes four, small, placed back of median transverse line.

Parapodia (fig. 52) rather long, dorsal ramus setigerous, ventral cirrus rudimentary or wanting. Dorsal setæ few, serrated, notched at extremity (fig. 52b). Ventral setæ only seven or eight, stout, hooked (52a), serrations almost obsolete.

Elytra (fig. 45) with inner margin curled up to form two funnels, the anterior ear-shaped, the posterior crescentic. Elytra thin and membranaceous, very slightly marked with yellow or pale green pigment; 29 to 34 pairs, borne on somites 2, 4, 5, 7, 9 . . . 23, 26, 28, 29, 31 . . . 57. Elytra do not cover dorsum.

Commensal (?) in ambulacral groove of *Asterias ochracea* and *A. troschelii*.

*Measurements*.—Length, 41 mm.; greatest width, 7 mm.; somites (in specimens of above dimensions) 60-70; the terminal ones very diminutive and difficult to count.<sup>1</sup>

With some hesitation I have identified the curious Polynoid above described as the *Halosydna fragilis* of Baird. His description is so defective, having been made from specimens which reached him in a fragmentary condition, that it would be quite impossible to recognize the species, were it not for its very peculiar habitat and abortive ventral cirri. The identity of the California specimens with material recently received from Puget Sound I have made out to my satisfaction; and this circumstance heightens the probability to a reasonable certainty that Baird's specimens and mine belong to one and the same species.

This species is very scarce in the neighborhood of San Francisco, and I have never found it south of this point. It occurs chiefly on *Asterias ochracea*; but even of this common species hardly one in fifty will be found to harbor a *Polynoë fragilis*. Northward, it is evidently far more abundant. Seven young specimens from vicinity of Seattle are stated by the youthful collector, John Dewhurst, to whom I am indebted for them, to have come from no more than a dozen starfish.

The parasite (or commensal) does not remain constantly in the ambulacral groove; sometimes it crawls upon the aboral side, where its peculiar coloration harmonizes so well with the colors of the starfish that it is by no means conspicuous. I have once found it on *Asterias troschelii*. Probably it occurs on all our larger species of *Asterias*. Whether the "parasitic worm" mentioned by Fewkes<sup>2</sup>

<sup>1</sup>In young specimens from Puget Sound (15-18 mm. long) the number of somites is 37-40.

<sup>2</sup>1. c. p. 129.



as infesting *Asterina mineata* is this species I have no means of knowing.

***Harmothoë imbricata* (L.) Malmgren.**

PLATE VII, FIG. 37.

This interesting species occurs all along our coast as far south at least as San Diego. The specimens from the southern parts of its range are small and few. Northward it increases in size. None of the numerous examples I have taken at Pacific Grove are so large as some from Humboldt Bay and from Puget Sound. Again, all the west coast specimens are dwarfs in comparison with Arctic examples.

At Pacific Grove it occurs under stones and among eelgrass, near low-water mark. It is extremely varied in its coloration, the tints ranging from pink to dark iron-gray. The first pair of elytra are very frequently a dull, opaque white, contrasting strongly with the general dark coloration, and giving the animal a very bizarre appearance, as having two great dull-white eyes.

I have no hesitation in placing my specimens under the name *Harmothoë imbricata*, although I have only figures and descriptions of the latter for comparison. The setæ correspond exactly; the prostomium (fig. 37) has the peculiar location of the eyes noted in *H. imbricata*—the anterior pair being placed laterally and actually under the bulging lobes of the prostomium. The relative length of tentacle and antennæ is almost precisely what it is in von Marenzeller's<sup>1</sup> figure of a specimen from Japan; but the difference in their lengths is not nearly so great as in Malmgren's<sup>2</sup> figure of the Skandinavian variety.

<sup>1</sup>Süd-japanische Anneliden I. Denkschr. d. Wiener Akad. Math. Naturwiss., Classe, Bd. XII, p. 117, Taf. II, fig. 1.

<sup>2</sup>Nordiska Hafs-Annulater; Öfversigt K. Vetensk-Akad., Förhandl., Bd. XXII (1866), Taf. ix, fig. 8a.

**Harmothoë hirsuta, sp. nov.**

PLATE VI, FIGS. 27, 28, 29; PLATE VII, FIG. 38; PLATE VIII, FIGS. 53, 53a, 53b, 53c.

Form short and broad, rather thin dorsoventrally, and only slightly tapered at posterior end; elytra not covering last four or five somites.

Prostomium typical for the genus, broader than long, with two well defined acuminate "peaks" (fig. 38); deeply incised for insertion of base of tentacle, which is distinctly at a higher level than the antennæ. Basal joint of tentacle thickened. Eyes four, anterior pair slightly the larger, laterally placed about half-way the length of prostomium, where it is widest. Posterior pair set far back, close to base of prostomium.

Antennæ less than one-third the length of the tentacle, and about one-half its thickness; their basal joints short, and not much thicker than the terminal joint, heavily pigmented. Terminal joints of all the cirri, both dorsal and ventral, more or less thickly beset with long, villous papillæ, among which extraneous matter has usually gathered in abundance. All dorsal cirri, including tentacle (but not the antennæ), with a broad zone of dark pigment at or near the proximal end of the distal segment. Palpi longer than any of the cirri, gently tapering to a fine point; minutely papillated, terete.

Parapodia (fig. 53) with large, bristling fascicles of setæ, those of dorsal ramus usually loaded with fine sediment. Dorsal ramus of medium size, but its setæ very numerous, long, and stouter than those of ventral fascicle, with long series of serrations (fig. 53c). Ventral setæ (fig. 53a) long, slender, numerous, toothed at tip, serrated for a considerable portion of their length; decreasing in length and size ventralward (figs. 53a, b). Both dorsal and ventral ramus with a finger-like terminal process.

Elytra (figs. 27-29) curiously ornamented with 4-6-pronged tubercles, these scattered over the whole surface in young elytra, but in old ones (except first pair) limited mainly to posterior and lateral margin, where they attain a very large size. Elsewhere they are much smaller. Each tubercle arises from a "space," which is bounded by thickened walls (fig. 29). Elytra also fringed and partly clothed with long filiform papillæ, or "cilia," like those of dorsal cirri.

Number of somites, 37 to 40. Pairs of elytra, 15, borne on somites 2, 4, 5, 7 . . . 23, 26, 29, 32.

*Measurements.*—Length of large specimen, 23 mm.; width of same, 6 mm.

Found at San Pedro in considerable abundance crawling on under side of stones at low-water mark and at moderate depths (3-4 fathoms). Its setæ, cirri, and curiously tuberculated elytra are usually coated with minute sediment.

This species bears a very close resemblance to *Polynoë polytricha* of the Caribbean region, first described by

Schmarda<sup>1</sup> and subsequently by Ehlers<sup>2</sup>. I have not had access to Schmarda's original description, but Ehlers' figures and diagnosis of *P. polytricha* show that that species differs in two or three important points from the present form. The palpi of *Harmothoë hirsuta* are terete, not angular; the eyes are four instead of two (Ehlers possibly overlooked the anterior pair, however), and the foot is shorter. Notwithstanding these differences, the two forms are exceedingly alike in a number of important characters, and may yet prove to be merely varieties of a single species.

### *Harmothoë crassicirrata*, sp. nov.

PLATE VI, FIGS. 25, 26; PLATE VII, FIG. 39; PLATE VIII, FIGS. 54, 55*a*, *b*, *c*.

Form rather stout and thick, tapered considerably towards the head; (posterior somites back of twenty-fifth wanting).

Prostomium (fig. 39) with lateral lobes well defined, anterior peaks prominent, acute, median fissure broad, reaching back about one-half the length of prostomium. Tentacle with broad, conical, basal segment, reaching a little beyond tips of prostomial lobes. Tentacle shorter than peristomial cirri, but nearly twice the length of the antennæ. The latter inserted below the level of the tentacle, their basal segments enormously thick and in all respects resembling the basal piece of tentacle. Flagellum of antennæ nearly equal in length to all the rest of the antenna. Eyes four, anterior pair much the larger, lateral, protuberant, placed about midway of length of prostomium and in its widest region. Posterior pair about one-half the diameter of the anterior ones, placed far back near base of prostomium.

Peristomial cirri very similar to tentacle, but considerably longer and thicker. The basal joints of dorsal and ventral cirri are fused for nearly their whole length. The dorsal cirri (fig. 25) clavate, and much thickened. All cirri, except ventral, papillate to some extent, the dorsal the least so.

Parapodia (figs. 25, 26) divided into very unequal rami, both with a long, cylindrical, finger-like, terminal process. Setæ of dorsal ramus very few (8-16), but enormously stout (figs. 55*a*, *b*), dark, minutely serrated their whole exposed length. Ventral setæ much more slender and numerous (fig. 55*c*), toothed at tip. Elytra probably 15 pairs, borne on somites 2, 4, 5, 7.... 23, 26?, 29?, 32?; thin, very broadly reniform (fig. 54), very smooth, and minutely flecked with brown pigment.

*Measurements*.—Greatest width of body, 7.5 mm.; length of 25 somites, 20 mm.

<sup>1</sup> Neue wirbellose Thiere, i, ii, p. 156.

<sup>2</sup> The "Blake" Annelids, Mem. Mus. Comp. Zool. Harvard College, Vol. XV, p. 49, Pl. X, figs. 9, 10. Pl. XI, fig. 1.

Unfortunately this interesting species is known from a single imperfect specimen, brought up on a stone from about 100 fathoms in Monterey Bay. The posterior segments back of the twenty-fifth are wanting, also the palpi, and one dorsal and one ventral peristomial cirrus. The striking differences in size between the head cirri and the dorsal cirri, between the dorsal and ventral setæ, are the notable points in the external structure of this form. The cirri and elytra are very readily detached.

### Family V. SIGALIONIDÆ.

#### *Peisidice*, gen. nov.

Body short, tentacle and the single pair of peristomial cirri identical in size and shape, large and conspicuous, longer than prostomium. Palpi short, not reaching beyond tips of peristomial cirri; no antennæ; no dorsal cirri. Dorsal rami of parapodia very small, bearing slender, fine-pointed, serrulate setæ. Ventral rami with much longer, stouter, compound setæ. Elytra not meeting across dorsum; exposed portion of latter, and upper surfaces of elytra coated with minute sand grains. Elytra borne on alternate somites, papillated on their external and posterior margins. Anal cirri two.

This genus, of which only a single species is known, differs from *Pholoë* and *Psammolyce*, to which it is evidently near akin, in the possession of only a single pair of peristomial cirri, and in the regularly alternating sequence of the elytra, whereas in *Pholoë* and *Psammolyce* they are borne on every somite after the twenty-third and twenty-seventh respectively. The body is likewise shorter, and the somites few (not over forty in known species).

#### *Peisidice aspera*, sp. nov.

PLATE IX, FIGS. 56-59; PLATE X, FIGS. 63, *a-d*.

Body elongate-elliptical, semiterete, equally and evenly rounded at both ends, its contour determined all around by the elytra, which cover over both head and parapodia. Wide median stripe of dorsum bare for nearly entire length; like the upper surface of elytra coated with sand grains.

Prostomium globular, bearing in front a large papillate tentacle (fig. 56), enlarged at the base, considerably swollen distally, and ending in a filiform tip. Single pair of peristomial cirri extremely similar to tentacle. Palpi short, stout, evenly tapered to a fine point, annulately grooved. Eyes

four, black, the two on each side closely approximated. No dorsal cirri; anal cirri similar in shape and length to the cephalic cirri.

Elytra, 17-19 pairs, borne on somites 2, 4, 5, 7....33. Elytra varying from trigonal to uncinatæ, the point of the "claw" toward the median line (fig. 56); they show distinct concentric growth-lines, and have a deep fringe of knobbed filaments on their posterior and external borders (figs. 56 and 59); the whole exposed upper surface of elytron with minute adherent sand grains. A varying number of elytra, beginning with the second pair, have a central dark spot.

Peristomial parapodia forwardly directed, with only a single pair of long, curved aciculæ and minute, simple, capillary setæ like those of all the dorsal rami (figs. 58, 63*d*). Ventral rami with a fascicle of much stouter, longer setæ, with falcate appendages (fig. 63*a*, *b*, *c*). Ventral cirri short, papillated, knobbed at tip, more or less coiled (fig. 58).

Jaws (fig. 57) double, strongly hooked at apex, horizontal in position, as seen *in situ* when retracted.

Somites 35 to 38 in number, all setigerous except the pygidial.

*Measurements*.—Length, 7 mm.; width 2 mm.

This curious little Sigalionid occurs in Monterey Bay, where I have dredged it in twelve fathoms on a stony bottom. They are found crawling over the stones and hiding in crevices. The body is closely incased laterally by the elytra, and further protected by the adherent sand particles, which render it rough to the touch. This singular mode of protection has been adopted, as is well known, in the allied genus *Psammolyce*. How the sand is held so firmly in place, and how the grains are so accurately selected as regards size and kind, is not apparent. Probably a secretion is produced by the dorsal surface and elytra, which hardens very firmly and effectively.

### *Sthenelais fusca*, sp. nov.

PLATE IX, FIGS. 60, 61, 61*a-b*; PLATE X, FIGS. 64, 64*a-g*.

Form elongated, tapered at posterior end, somites very numerous (138 or more); general color above, rusty brown, mottled with black, pale below. Elytra, over 100 pairs (112 in one specimen), entirely covering the back and the sides as far down as the parapodia.

Prostomium (fig. 60) rounded, eyes four, anterior pair placed far forward, nearly concealed under antennæ (?) as viewed from above. Tentacle short, slightly moniliform towards tip; antennæ (?) very short, flattened, and foliate.

Peristomial somite with a pair of forwardly directed setigerous parapodia, each bearing two cirri, similar in shape to tentacle and the dorsal one about

same length; the ventral much shorter. Palpi long, terete, smooth, usually twisted and coiled in preserved specimens. Spoon-shaped organs<sup>1</sup> small, somewhat shorter than ventral peristomial cirrus.

First pair of elytra whitish, rhomboidal; all the rest (fig. 61) reniform, broader on somites 2-27, narrower back of this point; papillate (fig. 61a) on ventrolateral margin; with minute, transparent tubercles (fig. 61b), and with two kinds of pigment—intra-cellular and cuticular (fig. 61b). Elytra borne on somites 2, 4, 5, 7...27, 28, 29, and on every succeeding somite.

Parapodia (fig. 64) elongated, strongly biramous at tip, all furnished with a terete, slightly tapering, branchial appendage, arising from external edge of elyptophore, constricted at its base, its tip usually in contact with the dorsal side of the parapod; fringed with long cilia on one side. Each branchia, beginning with the twenty-fifth, has a black pigment spot on its upper side, nearer the base in the anterior, but nearer the tip in the posterior branchiæ. This spot disappears on the most posterior branchiæ. Between the base of the branchia and the point where the parapod divides occur three ciliated cushions (fig. 64), of which the middle is twice the width of the other two. Tip of anterior ventral rami with several finger-like processes. Dorsal setæ very long, capillary, dorsally curved, serrulate on two borders (figs. 64, 64f, 64g). Ventral setæ (figs. 64, 64a-e) of four kinds: (1) a small fascicle of simple, spirally frilled setæ, projecting in the fissure between the rami (fig. 64e); (2) next to these three or four very stout, jointed setæ with moderately long, toothed appendage (fig. 64c, d); (3) stout, jointed setæ with very short appendages (fig. 64b); (4) slender, articulated setæ in lowest portion of series (fig. 64a). Ventral cirrus not reaching tip of parapod; with wing-like expansion on dorsal aspect, and slightly moniliform near tip.

*Measurements.*—Length of full-grown specimen, 95 mm.; width., 7 mm.

*Sthenelais fusca* frequents crevices under stones and among the rhizomes of the "eel-grass" (*Phyllospadix*), along a large portion of the California coast. It is apparently a rare species, for we have found thus far only four specimens: two in the vicinity of San Pedro, and two in the vicinity of San Francisco (at Pillar Point, San Mateo County, and at Bolinas, Marin County). All the specimens were taken at low-water mark during a run of low tides, so it is probable that beyond the littoral zone it occurs much more abundantly.

Three of the specimens are females, turgid with nearly ripe eggs of a bluish gray color. They were collected in June, July, and November.

<sup>1</sup> These are described at length by Claperède (Ann. Chaet. du Golfe de Naples, 1867, p. 399).



***Sthenelais verruculosa*, sp. nov.**

PLATE IX, FIGS. 62, 62a; PLATE X, FIGS. 65, 65a-d.

Body subcylindrical, slightly flattened on ventral side, entirely covered dorsally and laterally, as low as the parapodia, by the strongly imbricating elytra. Not tapered toward the head. Color of alcoholic specimen fulvous; a median dark band on each elytron, just meeting the overlapping edge of the preceding elytron.

Prostomium rounded, broader than long. Eyes four, black; the larger, posterior pair on dorsal side of prostomium, near insertion of basal joint of tentacle. The smaller, anterior, forwardly directed pair under the bases of the antennæ. Tentacle smooth, two-jointed, terete, tapering gradually and evenly to the point; about three times the length of the prostomium. Antennæ (?) broad, expanded laterally at tips, hardly reaching beyond distal end of basal joint of tentacle. Palpi elongated, smooth, terete, evenly tapered from the thick base to the attenuated tip; when folded back reaching to the tenth somite.

Peristomial somite pushed far forward, concrescent around bases of palpi, which appear to grow out from it. Its setæ capillary, unjointed, much finer than those of dorsal rami. Peristomial cirri four, dorsal pair much the longer, reaching to tip of tentacle. Spoon-shaped organs present, their tips reaching beyond the ends of the forwardly directed peristomial parapodia.

Elytra (Pl. IX, figs. 62, 62a) reniform, closely beset on dorsal surface with numerous, minute, wart-like tubercles. Outer margin of elytra with a single row of short, blunt, cylindrical papillæ (fig. 62a). Elytra bent in a semicircle around body; borne on alternate somites to twenty-seventh, thereafter on every somite; the latter group of elytra narrower and more curved than the former.

Parapodia (Pl. X, fig. 65) similar to those of *S. fusca* in general aspect; branchiæ arising from ventral edge of elytraphore, depressed, their tips touching the dorsal ramus, constricted at base. Tips of ventral rami prolonged in ramose structures, largest on second and third pairs, gradually reduced on succeeding parapodia. Ventral cirri elongated on three most anterior parapodia; the rest reaching to tip of ventral ramus, winged on side next the ramus, slightly moniliform toward the point. Dorsal setæ (fig. 65d) very similar to those of preceding species. Ventral setæ of three kinds: (1) slender, articulated setæ (fig. 65a), occupying the lowest place in the fascicle; (2) stout articulated setæ (fig. 65b), inserted above the former; and (3) simple, frilled setæ (fig. 65c), gathered in a small fascicle on dorsal aspect of ventral ramus. Three ciliated cushions, extremely like those of *S. fusca*.

*Measurements*.—Length, unknown; width, 3.3 mm.

A single imperfect specimen was dredged on a sandy bottom in ten fathoms off White's Point near San Pedro. The fragment, which is well preserved, consists of about forty somites of the anterior end.

## EXPLANATION OF THE PLATES.

Unless otherwise stated, all the figures have been outlined with camera lucida and the details filled in free-hand. The fine structure of setæ, paleæ, and elytra has in every instance been studied with a much higher power than the magnification of the figures would indicate.

## EXPLANATION OF PLATE V.

Figs. 1-7 illustrate *Euphrosyne*.

Fig. 1. "Gill" of *Euphrosyne aurantiaca*, sp. nov. The darker lines indicate the more refractive axial substance (blood-vessels?). In glycerine;  $\times 36$ .

Fig. 2. Tip of simple, bifid, dorsal seta, *E. aurantiaca*. In glycerine;  $\times 300$ .

Fig. 3. Tip of ringent, serrated, dorsal seta of the same. In glycerine;  $\times 300$ .

Fig. 4. Tip of one of the stouter, bifid, ventral setæ of the same. In water;  $\times 300$ .

Fig. 5. "Gill" of *Euphrosyne arctica*, sp. nov. In glycerine;  $\times 36$ .

Fig. 6. Tip of ringent, serrated, dorsal seta, *E. arctica*. The stippling indicates particles of calcic carbonate, with which all the setæ of *Euphrosyne* are impregnated. In water;  $\times 300$ .

Fig. 7. Tips of ventral setæ, large and small, of the same. In water;  $\times 300$ .

Figs. 8-14 illustrate *Eurythoe californica*, sp. nov.

Fig. 8. Anterior end of *Eurythoe californica*, from San Pedro, California. Alcoholic specimen;  $\times 19$ .

Fig. 9. Posterior aspect of a middle parapod of female specimen from Pacific Grove, California. In glycerine;  $\times 19$ .

Fig. 10. Tip of serrated, dorsal seta. Cleared in glycerine;  $\times 300$ .

Fig. 11. Tips of smooth, dorsal setæ, slender and stout;  $\times 300$ .

Fig. 12. Tip of long, slender, bifid seta from upper portion of the ventral series;  $\times 300$ .

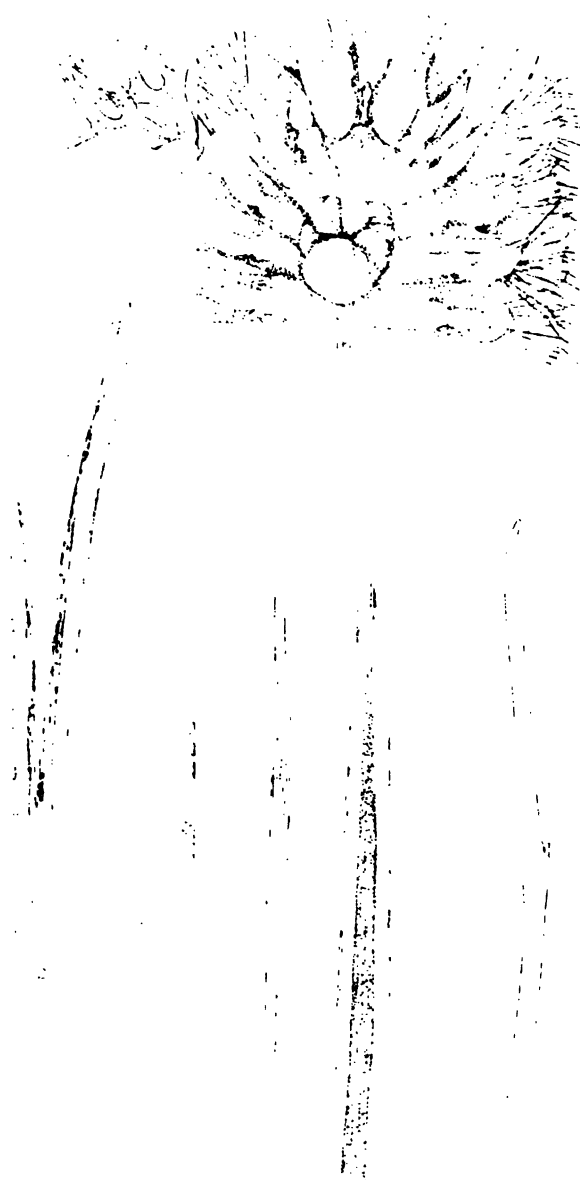
Fig. 13. Tip of short, stout, bifid seta from lower portion of ventral fascicle;  $\times 300$ .

Fig. 14. Greater portion of one of the short, hastate setæ of the ventral fascicle. In glycerine;  $\times 300$ .

Fig. 15. Cephalic lobe of *Chrysopetalum occidentale*, sp. nov., with tentacle and antennæ;  $\times 86$ .

Fig. 16. Ventral aspect of anterior end of *C. occidentale*. Proboscis partially everted;  $\times 86$ .









## EXPLANATION OF PLATE VI.

Figs. 17-23 illustrate Palmyridæ.

Fig. 17. A middle parapod of *Chrysopetalum occidentale* as seen in profile under pressure of cover glass, which brings the cirlet of paleæ nearly into one plane;  $\times 78.75$ .

Fig. 18. Palea of the same;  $\times 300$ .

Fig. 19. Setæ from ventral fascicle of the same; *a*, one of the uppermost; *b*, one of the lowest of the series;  $\times 510$ .

Fig. 20. *Heteropale bellis*, gen. et sp. nov. Anterior extremity, including head and first four setigerous somites. The paleæ of the third parapod on the right side, and of the fourth somite, are omitted. In glycerine;  $\times 82.5$ .

Fig. 21. A middle parapod of the foregoing; posterior aspect. In glycerine;  $\times 97.5$ .

Fig. 22. One of the largest and most external of the broad paleæ of the same. In glycerine;  $\times 300$ .

Fig. 22a. Narrow, lateral palea of the same;  $\times 300$ .

Fig. 23. Setæ from ventral fascicle of *H. bellis*; *a* one of the highest; *b* one of the lowest of the series. In glycerine;  $\times 510$ .

Figs. 24-29 illustrate Polynoidæ.

Fig. 24. *Polynoë (Halosydna) brevisetosa* (KINBERG). Dorsal aspect of anterior and posterior extremities of a young specimen 27 mm. long. As often happens, the elytra are lax, leaving the head and part of the back uncovered;  $\times 3$ . (Drawn without camera from a specimen preserved in formalin.)

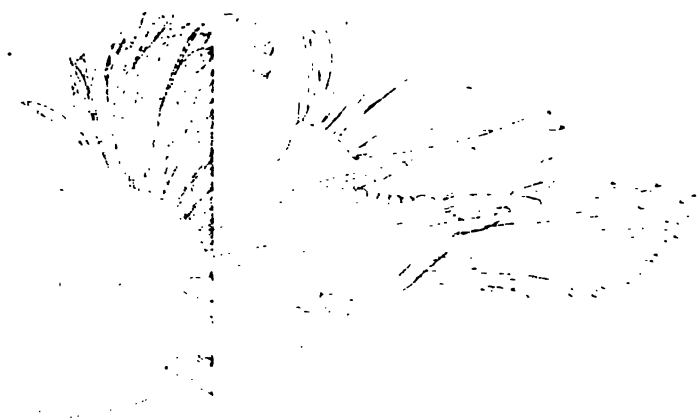
Fig. 25. Dorsal aspect of seventeenth parapod of *Harmothoë crassicerata*, sp. nov., right side;  $\times$  circa 18. (Drawn from life without camera lucida, but accurately as possible.)

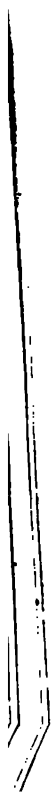
Fig. 26. Posterior aspect of twenty-second (elytrophorous) parapod of the same, formalin specimen. Position of aciculæ indicated as seen after clearing and mounting in balsam;  $\times 19.5$ .

Fig. 27. Elytron from right side, second pair, of *Harmothoë hirsuta*, sp. nov. The elytron has a fringe of "cilia" on two-thirds of its periphery (external and posterior borders). The denticulate tubercles are enormously large along posterior margin, each arising from a "space";  $\times 12.75$ .

Fig. 28. The same. A small portion of elytron, more magnified. From the antero-lateral border, where the "cilia" begin, and where the spaces, each with its tubercle, are most distinct. One "space" filled in with the pigmented cells; the others left blank. Transmitted light; glycerine;  $\times 110$ .

Fig. 29. A single "space" near margin of same elytron, with a large tubercle. Transmitted light; glycerine;  $\times 82.5$ .







## EXPLANATION OF PLATE VII.

Figs. 30-39 represent prostomia of different species of Polynoidæ, all magnified 19.5 diameters.

Fig. 30. *Polynoë (Lepidonotus) squamata* (L.) AUD. ET M.-EDW.

Fig. 31. *Polynoë (Halosydna) brevisetosa* (KINBERG).

Fig. 32. *Polynoë reticulata*, sp. nov.

Fig. 33. *Polynoë gigas*, sp. nov.

Fig. 34. *Polynoë pulchra*, sp. nov. With tentacle and antennæ.

Fig. 35. *Polynoë (Halosydna) lordi* (BAIRD). With tentacle and antennæ.

Fig. 36. *Polynoë (Halosydna) fragilis* (BAIRD). Broken base of tentacle in end view.

Fig. 37. *Harmothoë imbricata* (L.) MALMGREN. The position of the anterior pair of eyes, which are invisible from above, is indicated by dotted areas.

Fig. 38. *Harmothoë hirsuta*, sp. nov.

Fig. 39. *Harmothoë crassicirrata*, sp. nov.

Fig. 40. Second elytron from right side of *Polynoë brevisetosa*, in its normal position. Lightly pigmented; young specimen;  $\times 12.75$ .

Fig. 40a. More magnified area of foregoing, showing cells, both pigmented and unpigmented, and one of the smaller mammilliform tubercles. In glycerine. Viewed as a translucent object by transmitted light;  $\times 300$ .

Fig. 41. Second elytron from right side of *Polynoë reticulata*. Young specimen;  $\times 17$ .

Fig. 41a. More highly magnified area of the same, showing reticulate and pitted upper surface. Most of the epithelial cells pigmented;  $\times 300$ .

Fig. 42. Second elytron from left side of *Polynoë gigas*, in its normal position. Epithelium of both sides pigmented; pigment of under side duller;  $\times 12.75$ .

Fig. 42a. Highly magnified portion of upper surface of elytron of *Polynoë gigas*, showing two pigment spots and epithelial cells. A few stomata (?) between the latter;  $\times 300$ .

Fig. 43. Second elytron from left side of *Polynoë pulchra*. Adult specimen from mantle cavity of *Lucapina crenulata*;  $\times 12.75$ .

Fig. 43a. A few epithelial cells from pigmented, posterior border of the same;  $\times 300$ .

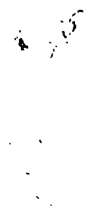
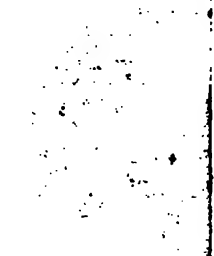
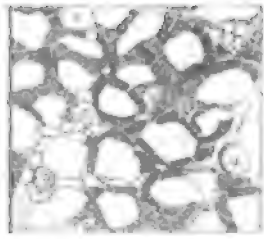
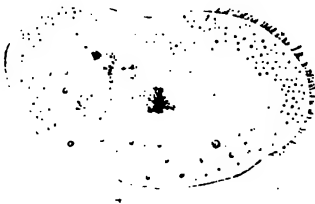
Fig. 44. Second elytron of *Polynoë lordi* (BAIRD). A nerve is clearly indicated. Immaculate;  $\times 12.75$ .

Fig. 45. Second elytron from right side of *Polynoë fragilis* (BAIRD), in its normal position; nerves from the elyrophore indicated;  $\times 19.5$ .



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## EXPLANATION OF PLATE VIII.

Fig. 46. Anterior aspect of twentieth left parapod of *Polynoë brevisetosa* (KINNEBEG). Viewed as an opaque object, but the position of the aciculæ indicated by dotted lines. Dorsal setæ short and small;  $\times 14.8$ .

Fig. 46a. Tip of seta from the ventral fascicle of the same;  $\times 228$ .

Fig. 47. Anterior aspect of twenty-second parapod of *Polynoë reticulata*;  $\times 14.8$ .

Fig. 47a. Tip of ventral seta of *Polynoë reticulata*, from about the middle of the series;  $\times 228$ .

Fig. 47b. A group of one long and two short setæ *in situ* in dorsal ramus of thirteenth foot of the same;  $\times 228$ .

Fig. 48. Posterior aspect of forty-fifth foot of *Polynoë gigas*;  $\times 14.8$ .

Fig. 48a. Seta-tip from about the middle of the ventral fascicle, thirty-second foot, of the foregoing;  $\times 228$ .

Fig. 48b. Tip of stout, uppermost seta of ventral fascicle of the same. Dark brown and nearly opaque. The tooth is worn off;  $\times 228$ .

Fig. 49. Sixty-ninth and seventieth somites of *Polynoë gigas*. The sixty-ninth has an elyrophore on the right, a dorsal cirrus on the left;  $\times 1.8$ .

Fig. 50. Anterior aspect of twenty-fourth foot of *Polynoë pulchra*. The dorsal ramus has only a single seta (often achæitous);  $\times 14.8$ .

Fig. 50a. Tip of a ventral seta of the same; moderately hooked;  $\times 228$ .

Fig. 50b. Tip of a dorsal seta of the same;  $\times 228$ .

Fig. 51. Anterior aspect of eighth parapod of *Polynoë (Halosydna) lordi* (BAIRD). Dorsal ramus achæitous; ventral ramus with five blunt, slightly curved setæ above the acicula, and a fascicle of hooked setæ below;  $\times 14.8$ .

Fig. 51a. Tip of a hooked seta from lower portion of ventral series;  $\times 228$ .

Fig. 51b. Tip of a blunt seta from upper portion of ventral series;  $\times 228$ .

Fig. 52. Profile view of fifteenth foot of *Polynoë (Halosydna) fragilis* (BAIRD). Dorsal setæ present, seven or eight in number. Nascent setæ imbedded within the ventral ramus represented by dotted lines;  $\times 14.8$ .

Fig. 52a. Ventral seta-tip from seventeenth parapod of *Polynoë fragilis*. In glycerine;  $\times 228$ .

Fig. 52b. Tip of seta from dorsal ramus of the same;  $\times 228$ .

Fig. 53. Anterior profile view of tenth foot of *Harmothoe hirsuta*. Balsam preparation;  $\times 14.8$ .

Figs. 53a, b. Tips of one of the longest and one of the shortest of the ventral setæ of the preceding. The difference in number of the serrations is striking;  $\times 228$ .

Fig. 53c. Seta-tip from the dorsal ramus of the same;  $\times 228$ .

Fig. 54. Elytron of *Harmothoe crassicirrata*. Glycerine preparation, seen by transmitted light;  $\times 7.23$ .

Fig. 55a. Entire dorsal seta from twenty-third foot of *H. crassicirrata*;  $\times 60$ .

Fig. 55b. Tip of the same, more magnified (the serrations are represented rather too distinctly);  $\times 228$ .

Fig. 55c. An average seta-tip from ventral fascicle of the foregoing;  $\times 228$ .





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## EXPLANATION OF PLATE IX.

Fig. 56. Anterior region of *Peisidice aspera*, gen. et sp. nov. Drawn from life without camera lucida, but accurately as possible;  $\times 20.25$ .

Fig. 57. Jaws of the same. Seen *in situ* from ventral side, proboscis retracted. Balsam preparation of entire worm;  $\times 52.5$ .

Fig. 58. Profile view, posterior aspect of a foot from middle of body of the foregoing. In cedar oil;  $\times 78.75$ .

Fig. 59. A small portion of lateral margin of one of the fifth pair of elytra, with six marginal "cilia." Glycerine preparation; transmitted light;  $\times 300$ .

Fig. 60. Anterior end of *Sthenelais fusca*, sp. nov., after removal of first two pairs of elytra. The anterior pair of eyes are minute and forwardly directed. Alcoholic specimen; about one-half grown;  $\times 12.75$ .

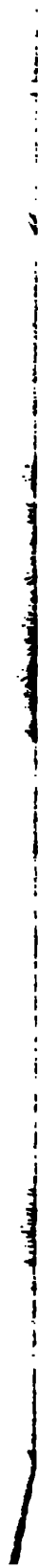
Fig. 61. Elytron from posterior region of body of *Sthenelais fusca*, left side. The nerves in the unpigmented portion of elytron are very distinct. Papillated on ventro-lateral region and margin. Glycerine preparation; transmitted light;  $\times 19.5$ .

Fig. 61a. A small portion of margin of same elytron, showing fusiform papillæ. The nerves can be traced into some of these papillæ;  $\times 225$ .

Fig. 61b. A small portion of upper surface of thirteenth elytron of the foregoing, including one of the minute non-pigmented areas. The cuticular pigment appears as rounded, amorphous masses. Glycerine; transmitted light;  $\times 225$ .

Fig. 62. Right elytron of eighth pair of *Sthenelais verruculosa*, sp. nov., showing the very numerous, small tubercles;  $\times 12.75$ .

Fig. 62a. A small portion of ventro-lateral margin of same elytron, showing tubercles and marginal "cilia";  $\times 300$ .







## EXPLANATION OF PLATE X.

Fig. 63. Seta-tips of *Peisidice aspera* from a middle parapod; *a* the lowest, *b* average, *c* the highest of ventral series; *d*, tip of dorsal seta;  $\times 228$ .

Fig. 64. Posterior aspect of twenty-sixth foot of *Sthenelais fusca*. In glycerine;  $\times 19.5$ .

Fig. 64*a*. Tip of slender, articulated seta from ventral series of a middle parapod of the preceding. Lowest in the series. Glycerine preparation;  $\times 228$ .

Fig. 64*b*. One of the medium, stout, jointed setæ of ventral ramus of the same. Glycerine;  $\times 228$ .

Fig. 64*c*, *d*. Tips of two of the strongest and uppermost of the ventral fascicle of the same. They are adjacent and the one to the left is the lower;  $\times 228$ .

Fig. 64*e*. Tip of one of the fascicle of frilled setæ from the ventral ramus of the same;  $\times 228$ .

Fig. 64*f*. Basal portion of one of the long, slender, serrated, dorsal setæ of the preceding; profile view. In glycerine;  $\times 228$ .

Fig. 64*g*. Frontal view of a small portion of one of the dorsal setæ;  $\times 228$ .

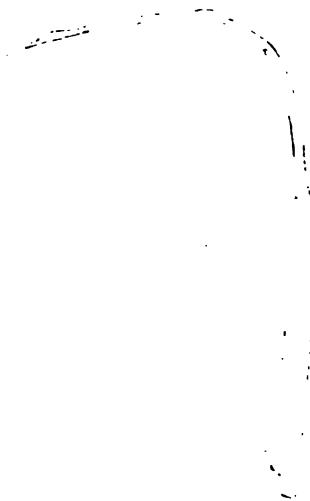
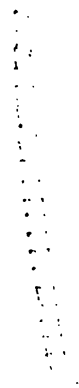
Fig. 65. Posterior aspect of fifteenth parapod of *Sthenelais verruculosa*. In glycerine;  $\times 19.5$ .

Fig. 65*a*. Tip of one of the slender, articulated, ventral setæ of the foregoing; from the lowest part of the fascicle;  $\times 228$ .

Fig. 65*b*. Tip of one of the stouter, articulated setæ of ventral fascicle of the same;  $\times 228$ .

Fig. 65*c*. Tip of one of the fascicle of simple, frilled setæ;  $\times 228$ .

Fig. 65*d*. Profile view of a portion of one of the long, curved, dorsal setæ. In glycerine;  $\times 228$ .



1. The first part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

PROCEEDINGS  
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CALIFORNIA ACADEMY OF SCIENCES.

ZOOLOGY.                      THIRD SERIES.                      Vol. I, No. 6.

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Description of a Species of Fish (Mitsukurina owstoni) from Japan, the  
Type of a Distinct Family of  
Lamnoid Sharks.

BY  
DAVID STARR JORDAN.

WITH TWO PLATES.

*Issued January 18, 1898.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1898.





DESCRIPTION OF A SPECIES OF FISH (MIT-  
SUKURINA OWSTONI) FROM JAPAN,  
THE TYPE OF A DISTINCT FAMILY  
OF LAMNOID SHARKS.

BY DAVID STARR JORDAN.

PLATES XI AND XII.

SOME time since, Mr. Allen Owston, a resident of Yokohama, Japan, secured from a fisherman a specimen of a very remarkable shark, obtained in deep water near Yokohama. Mr. Owston, through Professor Kakichi Mitsukuri, presented this specimen to the University of Tokio.

In coming to the United States as a delegate to the International Fur Seal Conference of 1897, Professor Mitsukuri brought this specimen with him, and he has placed it in my hands to be identified, figured, and described.

It proves to be not only a remarkably distinct new genus of lamnoid affinities, but also the type of a distinct family.

The accompanying figures have been drawn by Mrs. Chloe Leslie Starks, under the direction of Dr. Theodore Gill, at Washington. The dissections necessary to show the singular characters were suggested by Dr. Gill, to whom the writer would express his especial obligations.

The type specimen has been returned to the Museum of the University of Tokio.

**Mitsukurina, gen. nov.**

Skeleton flexible; snout produced in a flat, flexible blade; spiracles large; teeth acicular, only the lateral ones with small basal cusps; last gill-opening above base of pectorals; fins all low, the ventral with very long base; the claspers very small; lower lobe of caudal long; no pit at root of caudal; first dorsal well advanced; second shorter and higher than anal.

**Mitsukurina owstoni**, sp. nov.

## PLATES XI AND XII.

Length of specimen, a male apparently young, 42 inches. Head (to first gill-opening)  $4\frac{1}{2}$  in length; depth about 10. Snout from eye  $1\frac{1}{2}$  in head; from front of mouth  $2\frac{1}{2}$  in head; length of blade of snout from its insertion below  $1\frac{1}{2}$  in head. Length of gill area  $2\frac{1}{2}$  in head; depth of last gill 6 in head; eye 12 in snout from eye; interorbital area  $2\frac{1}{2}$  in snout from eye; spiracle a little smaller than eye; length of one mandible  $2\frac{1}{2}$  in head; length of maxillary  $2\frac{1}{2}$  in head. Pectoral base  $1\frac{1}{2}$  in length of pectoral fin, which is  $2\frac{1}{2}$  in head. First dorsal base  $1\frac{1}{2}$  in its height, which is  $2\frac{1}{2}$  in head. Second dorsal base  $1\frac{1}{2}$  in its height, which is 3 in head. Ventral base 2 times its height, the length of the base being 3 in head. Claspers very short (perhaps immature), nearly 12 in head. Anal base  $2\frac{1}{2}$  times its height and  $2\frac{1}{2}$  in head. Caudal measured from above  $2\frac{1}{2}$  in length of body; greatest height of lower lobe nearly 3 in head.

Body elongate, compressed behind, the flesh and skeleton extremely limp, folding like a wet rag; head moderate, the snout produced in a long, flat, flexible, leaf-like blade, somewhat like that of *Polyodon spathula* but arrower, more limp and more pointed; median line of snout with a thick, rounded, median keel; the lower side of the blade free for a considerable distance backward from the upper jaw, almost to the eyes. Mouth inferior, with elongate cleft; the dentary bones broad, loosely connected, and movable, capable of being spread wide apart, but normally lying close together and nearly parallel; a notch at symphysis, the tip of the lower jaw strongly curving upward and inward at tip; a similar notch at tip of upper jaw between the rather loosely joined maxillary.

Teeth few-rowed, about  $\frac{1}{2}$  on each side; middle of each jaw without teeth in front. Teeth all needle-shaped, very slender and pointed, more or less curved backward or inward; each tooth with a two-rooted base; the large teeth in front simple, the smaller ones on sides of jaws each with two small basal cusps; second and third tooth of lower jaw longest; the second about as long as eye; first and second tooth of upper jaw similar to these but somewhat shorter; lateral teeth of both jaws progressively smaller, but all slender and sharp.

Eye small, without nictitating membrane; spiracle large; gill-openings about equal in height, the last above base of pectoral.

Skin everywhere rough, the scutes very small, granulated. No lateral line or conspicuous mucous pores; nostrils large, about as large as eye, their distance from eye twice the eye; each nostril with a small notch on lower edge and a free flap within.

Fins all thin, flexible, and papery; the broad bones somewhat exerted from the soft flesh. Pectoral short, narrow, and rounded, the flexible rays longest. First dorsal short and moderately high, not emarginate; second dorsal lower, remote from the first, the interspace being  $1\frac{1}{2}$  in head. Insertion of first dorsal above axil of pectoral; insertion of second nearly midway between ventrals and anal. Ventrals with very long base; anal much longer

than second dorsal and rather lower; no caudal keel; no pit at root of caudal; lower lobe of caudal long and rather high, with a sharp notch near its tip.

Color light reddish gray, brownish above; the fins darker brown; nuchal region a little darker; belly paler.

The genus is apparently unique among living forms, its nearest relative being apparently the genus *Carcharias* of Rafinesque, which is *Odontaspis* of Agassiz. This group contains few recent sharks, but is rich in fossil forms. Unless place can be found for it in some family of fossil species, it must stand as the type of a distinct family *Mitsukurinidæ*.

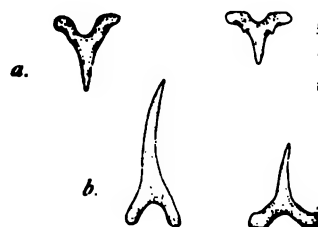
I take great pleasure in associating this remarkable animal with the name of my honored friend and colleague, the distinguished Professor of Zoology in the University of Tokio, with the Hon. Shiro Fujita, joint representative of Japan in the International Conference of 1897 in the interest of the protection of the fur seals.

The specific name, in recognition of Mr. Owston's interest in his discovery, is given at the request of Professor Mitsukuri.

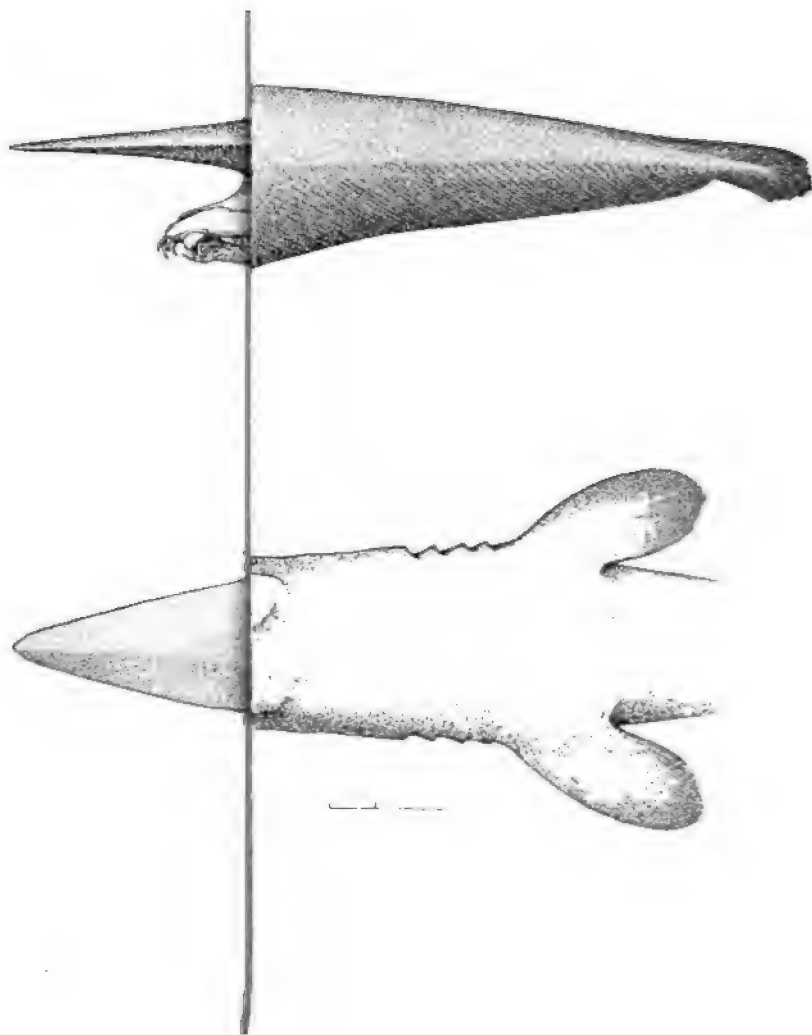
LELAND STANFORD JUNIOR UNIVERSITY,  
CALIFORNIA,  
January, 1898.

## EXPLANATION OF PLATE XI.

- Fig. 1. Side view of *Mitsukurina owstoni*, gen. et sp. nov.
- Fig. 2. Top view of head.
- Fig. 3. View of head from below.
- Fig. 4a. Teeth of upper jaw, 2d, 3d and 9th.
- Fig. 4b. Teeth of lower jaw, 2d, 5th, 9th and 10th.
- Fig. 5. Section of skin of side.
- Fig. 6. Nostrils.

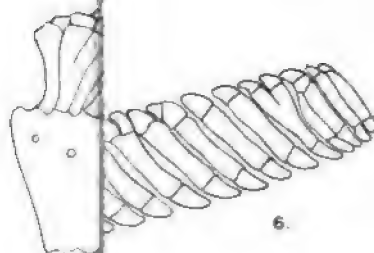
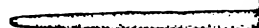
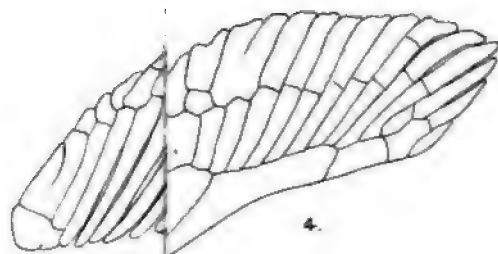


6.



## EXPLANATION OF PLATE XII.

- Fig. 1. Skull of *Mitsukurina owstoni*, gen. et sp. nov.
- Fig. 2. Basal bones of first dorsal.
- Fig. 3. Basal bones of second dorsal.
- Fig. 4. Basal bones of left pectoral.
- Fig. 5. Basal bones of left ventral fin.
- Fig. 6. Basal bones of anal fin.





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PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES.

THIRD SERIES.

ZOOLOGY.

VOL. I, No. 7.

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Arachnida from Baja California and  
Other Parts of Mexico.

BY

NATHAN BANKS.

WITH FIVE PLATES.

*Issued May 28, 1898.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1898.



## ARACHNIDA FROM BAJA CALIFORNIA AND OTHER PARTS OF MEXICO.

BY NATHAN BANKS.

PLATES XIII-XVII.

THE Arachnida, collected by Dr. Gustav Eisen and Frank H. Vaslit, under the auspices of the California Academy of Sciences, in Baja California and other parts of Mexico, were sent to the late Dr. Geo. Marx for determination and description. On the occasion of his death they were (with the exception of the Phalangida) sent to the writer. Dr. Marx had performed considerable mechanical work in the separation of the various species, and also some descriptive work. Part of the latter was so fragmentary as to be of no service; the descriptions which were completed, however, and which could be connected with the specimens, are incorporated in this article nearly as Dr. Marx wrote them, though in many cases there are slight changes or corrections. These species, of course, should bear Dr. Marx's name. Several of the species which he had described were not new, and so their descriptions are omitted. Anyone familiar with Dr. Marx's methods of work will not be surprised to learn that many of the specimens, when sent to me, bore no locality label whatever. Doubtless he knew where they came from, but left no clew that others might use. Some of the species were numbered, and by examining several of his series of numbers it was possible to find localities and his name for the species.

Dr. Marx (according to his notes) sent a number of specimens to the eminent French arachnologist, E. Simon. These M. Simon described in a paper entitled "*Descriptions de quelques Arachnides de Basse-Californie faisant partie des collections du Dr. Geo. Marx,*" published in Bull. Soc. Zool. d. France, 1895. M. Simon also recorded and described some species from Baja California collected by

M. Digue in a paper entitled " Sur les Arachnides recueillis en Basse-Californie par M. Digue." In these two papers the following species are recorded which I have not recognized in this collection:

*Chorizomma pallens* SIM.  
*Eurypelma steindachneri* AUSS.  
*Lithyphantes fulvus* KEYS.  
*Gasteracantha ellipsoidea* WALCK.  
*Misumena americana* KEYS.  
*Thanatus rubicundus* KEYS.  
*Selenops aissa* WALCK.  
*Phidippus rimator* WALCK.  
*Pardosa californica* KEYS.  
*Mævia californica* PECK.  
*Pæcilochroa concinna* SIM.

A few of these are, I believe, wrong determinations.

Previous to M. Simon's brief papers, nothing was known of the arachnid fauna of Baja California, nor of the west coast of Mexico; and great credit is due to the collectors, that amid the abundance of material in other groups they should have paused to gather such a collection of spiders as to place our knowledge of the arachnid fauna of this interesting region on a solid basis.

The collection may be roughly divided into two portions: that from the Cape Region of Baja California, and that from Tepic and other places on the mainland of Mexico. The collection from Tepic contains many species known from the southeastern part of the United States, yet with a considerable admixture of much more tropical forms. The spiders from the Cape Region of Baja California are more anomalous; they contain a larger percentage of truly tropical species, but yet such a number of forms connecting them to the fauna of the mainland that I did not think it necessary to treat this collection separate from that of Tepic. Guaymas, on the west coast, exhibits many affinities with the fauna of the Cape; while from Orizaba, in east Mexico, come a number of spiders well known in the Atlantic States.

Regarding the Cape fauna in particular, one will at once notice the occurrence of certain spiders of a truly tropical appearance. Such are *Artema atlanta*, a Pholcid found in houses throughout tropical America; *Heteropoda venatoria*, a large species common in the tropics of both hemispheres; species of *Selenops*; an *Hersilid*; two species of Caponidæ, curious two-eyed spiders; an *Oonopid*; several species of Epeiridæ, as *Cyrtophora fusiformis*, *Argiope argentata*, and *Gasteracantha hexacantha*; and various species in other families. One species, *Nephila hasselti*, was previously known only from the eastern part of Asia.

Of the peculiarities of this Cape fauna, one may call attention to the abundance of species of *Lithyphantes* and of *Habrocestum*, while the true *Theridiums* are not numerous, and there are no species of *Philodromus*. The Drassids are very numerous in species, though quite rare in specimens. One interesting feature of the collection was the large number of specimens of the curious Solpugids and certain Phrynidæ. These are so rare in collections that such an abundance of material fills one with wonder.

I have been able to identify but few species with those described by the Rev. O. P. Cambridge in the "Biologia Centrali-Americana." His spiders for the most part seem to come from quite different regions. Prof. Peckham has recently published a large paper on Central American Attidæ; but few of these are represented in this collection.

Altogether there are 315 species, 298 of which are true spiders, classed in 28 families. The Epeiridæ leads with a total of 50 species; then follow the Theridiidæ, Attidæ, and Lycosidæ. Seven families are represented with but one species. The types of new species are in the Academy.

Of the localities referred to the following are in the Cape Region of Baja California: Sierra San Lazaro, Sierra Laguna, Sierra San Nicolas, Agua Caliente, San Francisco, Coral de Piedras, San José del Cabo, La Chuparosa, El Taste, La Palmilla, Las Palmas, Pescadero.

The following places are in Baja California north of the Cape Region: San Julio, Ensenada, Calmilla Mines, Santa Margarita Island, San Quintin, Magdalena Island.

Tepic, Orizaba, Mazatlan, Vera Cruz, Minititlan, Guaymas, Motzoronga Hermosillo, and San Miguel de Horcasitas are in Mexico, Guaymas, Hermosillo, and San Miguel de Horcasitas being in the Sonoran region.

### THERAPHOSIDÆ.

1. *Eurypelma caniceps* *Sim.*.—One female, probably this species, which was described from a male; Tepic, Oct.
2. *Eurypelma rusticum* *Sim.*.—Several from San José del Cabo.
3. *Eurypelma helluo* *Sim.*.—Two examples from Sonora.
4. *Pachylomerus pustulosus* *Becker.*.—Several from San José del Cabo.
5. *Entychides dugesii* *Sim.*.—One specimen from San José del Cabo.
6. *Evagrus mexicanus* *Auss.*.—A number from Tepic, Oct. and Nov., and Sierra San Lazaro, Sept. In all specimens the maxillæ are pale on the inner margin. I doubt if *E. rubrigularis* is anything different.

### FILISTATIDÆ.

7. *Filistata hibernalis* *Hentz.*.—Many specimens; San José del Cabo, Sierra San Lazaro, Sept., San Miguel de Horcasitas, Guaymas, and Tepic.

### PLECTREURIDÆ.

8. *Plectreurys castanea* *Sim.*.—Several from San José del Cabo.
9. *Plectreurys bicolor*, sp. nov.

PLATE XIII, FIG. 9.

Length ♂ 7 mm. Cephalothorax and sternum rufous; mandibles more brownish; legs reddish yellow, brownish on apical half of femora; abdomen

uniform dark gray; young specimens have cephalothorax yellowish and abdomen paler gray. Cephalothorax nearly twice as long as wide, but little narrowed in front. Legs quite long; femora stout, I curved in ♂, as long as cephalothorax; in ♀ a little shorter; metatarsus I of ♂ with a projection at the tip bearing a black spine; metatarsus I nearly straight; tarsus curved in ♂; all legs hairy; several spines on the inner side of femur I near tip, five or six spines below on tibia I; mandibles stout, slightly porrect. Posterior eyerow barely recurved, anterior row nearly straight; A. M. E. smaller than other eyes and less than their diameter apart; S. E. slightly separated; M. E. form a trapeze broader behind than long; P. M. E. a little more than diameter apart and closer to each other than to the S. E. Sternum and mouthparts as in the other species. Abdomen once and a half as long as broad, rounded behind and in front, quite high and convex, thickly clothed with blackish hairs.

A few specimens from San José del Cabo and Sierra Laguna. It differs from *P. castanea* in color, in ♂ having a projection to tibia I; from *P. tristis* in the color, in straighter metatarsus I, and coiled tube of palp.

10. *Diguetia canites* McCook.

*Segestria canites* McCook, Am. Spiders and their Spinning Work, II, p. 133.

Two specimens of this remarkable spider from Sierra San Nicolas. It is known to me from Southern California and Southern Texas.

SCYTODIDÆ.

11. *Loxosceles rufescens* Duf.—Various specimens from Agua Caliente, San José del Cabo, La Chuparosa, and Sierra San Lazaro, Sept.

12. *Scytodes lineatipes* Tacz.—Two specimens from Magdalena Island.

13. *Scytodes bajula* Sim.?—Two specimens, probably this species, from Mazatlan.

14. *Scytodes fusca* Walck.—A few specimens from San José del Cabo, El Taste, and Hermosillo.



**15. *Scytodes perfecta*, sp. nov.**

PLATE XIII, FIG. 2.

Length ♀ 7 mm., ♂ 6 mm., ceph. 3.2 mm. long, femur I 4.2 mm. Cephalothorax pale yellow, marmorated with brown marks on the plan of *S. thoracica*, in some specimens the markings nearly obliterated; legs pale, without markings; sternum pale yellow; abdomen grayish, above two rows of five or six black spots, the basal pairs longer and somewhat connected, two or three smaller spots on each outer side. Cephalothorax moderately high, quite broad; M. E. touching, equal in size to other eyes; sternum once and a half longer than broad, truncate behind. Legs slender, in ♂ femora I are furnished each side with a row of short, stiff spines, in the ♀ clothed with fine hair. Abdomen subglobose, longer than broad, broadly rounded behind, clothed as also the cephalothorax with short bristly hairs. The ♂ palpus is short; tibia once and a third longer than broad; tarsus long, curved, slender, bulb large, tapering gradually to the long, straight tube, which projects much beyond the tarsus.

A few specimens from San José del Cabo and San Miguel de Horcasitas.

**16. *Scytodes mexicanus*, sp. nov.**

PLATE XIII, FIG. 1.

Length 8 mm., ceph. 3.8 mm. long, femur I 5 mm. Cephalothorax pale, marked with dark brown, a transverse mark in front on M. E.; behind is a median line to near middle of the cephalothorax, each side is a broader line connected to a spot around the S. E., and on the middle connected to a large broad stripe extending backward and curved toward the center behind and then away from it, giving off each side several paler bands forming a rough network on each side of the cephalothorax; a spot on mandibles; a line on outside of maxillæ; sternum pale, with brown spots around the edge and some in center; legs pale, small spot on base and large one on tips of coxæ; femora with median and apical rings and several irregular ones near base, a spot on under side of patellæ, three rings on the tibiæ besides the extreme base, and a spot and a line under the metatarsi; abdomen gray, blackish above near tip, showing a few narrow, pale chevrons; venter with a few scattered black spots. The cephalothorax moderately broad and high; M. E. barely touching, hardly as large as S. E.; legs slender, but not near as long as in *S. longipes*; sternum once and a third longer than broad, rounded behind; abdomen subglobose, longer than broad and pointed behind.

One specimen; Mexico City.

**ÆCOBIIDÆ.**

**17. *Thalamia parietalis* Hentz.**—One specimen, without locality.

## HERSILIIDÆ.

18. *Tama mexicana* Cambr.

*Hersilia mexicana* CAMBR., Biol. Cent.-Am., Arach.-Aran., p, 107.

One immature specimen, probably from San José del Cabo.

## OONOPIDÆ.

19. *Gamasomorpha rufa*, sp. nov.

PLATE XIII, FIG. 12.

Length 1.8 mm. Cephalothorax, sternum, and abdomen reddish, except the soft rim, which is yellowish; legs and palpi yellowish; the hard parts punctulate, and everywhere scantily clothed with moderately long hairs. Cephalothorax once and a third as long as broad, narrow in front, high in second third, convexly sloping to the clypeus which is very low, behind sloping at first concavely and steeply, then more gradually and convexly, no dorsal groove, S. E. equal, touching; P. M. E. larger, touching each other, and but slightly separated from the S. E.; posterior row distinctly recurved; maxillæ inclined over the short lip; sternum a little longer than broad, truncate between the hind coxæ. Legs short; femora thickened at base; tarsi much shorter than metatarsi, without spines, but quite hairy; coxæ subglobose. Abdomen oval, once and a half as long as broad, depressed, wholly covered above by a horny shield, and another below reaching from base to near the spinnerets; a horny semicircle at base of the spinnerets; a dark stripe each side near furrow.

Two examples; no locality.

## CAPONIDÆ.

20. *Nops ovalis*, sp. nov.

PLATE XIII, FIG. 6.

Length ♀ 7.5 mm., ♂ 5 mm. Cephalothorax and sternum reddish yellow; legs, palpi, and mandibles paler; abdomen pale gray; spot surrounding the eyes black. Cephalothorax long, oval; head barely narrowed in front; eyes small, about their diameter apart; sternum once and a half as long as broad. Legs with fine, long hairs; anterior pairs short and stout; femora much thickened; tarsi about one-half as long as metatarsi, and not near as long as breadth of femur I; the metatarsi straight and not divided; the tarsi biarticulate.

A few specimens; San José del Cabo and Sierra San Lazaro, Sept.

**21. *Nops sternalis*, sp. nov.**

PLATE XIII, FIG. 5.

Length ♀ 5 mm. Cephalothorax, sternum, legs, palpi, and mandibles pale yellowish; eye-spot black; abdomen pale gray. The cephalothorax is nearly circular in outline; head much narrowed in front; eyes large, more than one-half their diameter apart; sternum barely longer than broad. Legs with many quite stiff bristles; anterior pairs slender, the femora barely thickened; metatarsus curved and divided beyond middle into seven or eight false joints; tarsus about one-third the length of metatarsus, and as long as breadth of femora I; divided into five or six false joints.

Two specimens from San José del Cabo.

**DYSDERIDÆ.****22. *Ariadne mexicana*, sp. nov.**

Length 10 mm., ceph. 4.2 mm. long, 2.4 mm. wide. The cephalothorax is shining chestnut brown, slightly darker in front; mandibles dark brown; legs yellow-brown, anterior pairs darker except at base; sternum yellow-brown, with faint darker spots each side; abdomen gray, darker above than beneath; everywhere clothed with fine hair. Very similar in structure to *A. bicolor*, but the cephalothorax and sternum more slender; the M. E. are round, touching, and much more than their diameter (farther than in *A. bicolor*) from the slightly larger S. E. The anterior femora are curved and have a spine on inner side as in *A. bicolor*; there are four pairs of spines under tibia I, six pairs under metatarsus I, the latter joint slightly curved, one spine under tibia III, none under tibia IV.

Two specimens; La Chuparosa.

**PHOLCIDÆ.**

**23. *Artema atlantica* Walck.**—San José del Cabo. Very common in the Cape Region of Baja California.

**24. *Physocyclus cornutus*, sp. nov.**

PLATE XIII, FIG. 41.

Length 6 mm. Cephalothorax pale, a large brown spot over center with dentate margins; eyes surrounded by black; on clypeus a brown stripe each side from group of S. E. to the mandibles; abdomen pale, with several irregular dark bands on each side; legs and sternum pale, with brown dots and brown rings at tips of the femora and bases and tips of tibiae. Cephalothorax flat, without thoracic elevation in the ♀; mandibles of ♂ striated near base

on outside, on inside with many granules, carinated, the ridge extending forward in the form of a horn. Abdomen higher than long; epigynum similar to *P. globosus*; eyes as in *P. dugesi*. Male palpus with the femur clavate, patella very short, tibia convex above, tarsi with a long projection, nearly truncate at tip (not long and flexuous as in *P. dugesi*), an inner, broader, longer projection, rounded at tip, and a third much shorter; inside is an ovate bulb.

Two males and two females; Cape Region.

**25. *Physocyclus globosus* Tacz.**—Sierra San Lazaro.  
Quite common in Baja California.

**26. *Physocyclus mexicanus*, sp. nov.**

PLATE XIII, FIG. 40.

Length 4 mm. Cephalothorax pale yellowish, with brown spot above connected forward with the eyes, three spots on each side, clypeus fuscous; sternum and legs pale, brown rings at tips of femora and on patellæ and on bases and tips of tibiæ; tips of palpi fuscous; abdomen pale, with some dark spots on each side. Cephalothorax without thoracic elevation; eyes as in *P. globosus*; abdomen about as high as long, somewhat flattened above; epigynum much like *P. globosus*, but with the anterior processes much longer and curved.

One specimen; Tepic, Nov.

**27. *Psilochorus minutus*, sp. nov.**

PLATE XIII, FIG. 42.

Length 2 mm. Cephalothorax pale yellowish, with a brownish spot above extending forward to each group of S. E.; S. E. on black spots and a black band passing through A. M. E. connecting them, from this band extends forward down on the clypeus a slender, pointed, black mark; clypeus is infuscated; legs and sternum pale, pale brownish rings on tips of the femora and bases and tips of tibiæ; abdomen pale bluish gray, marked with darker bluish and many silvery spots; region of epigynum yellowish, a prominent dark spot on each side of venter behind the epigynum. Cephalothorax low and eye-region somewhat elevated; posterior eye-row slightly procurved; A. M. E. much smaller than other eyes; P. M. E. once and a half their diameter apart. Legs slender, femora thickened toward base, tarsi indistinctly divided; mandibles quite long and slender, a tooth in front over each fang; abdomen a little longer than high, somewhat globose; epigynum projecting conically, a curved transverse ridge; sternum very broad, broadly truncate behind.

One specimen; Sierra San Lazaro, Sept.

## ZOROPSIDÆ.

28. *Zorocrates fuscus* Sim.—Two specimens from Orizaba.

29. *Zorocrates badius* Sim.—Several from La Chuparosa and San Francisquito.

30. *Zorocrates pictus* Sim.—Several from El Taste and Coral de Piedras.

## ZODARIIDÆ.

31. *Homalyonchus selenopoides* Marx.—Quite a number of specimens, mostly immature; San José del Cabo, and Sierra San Lazaro, Sept.

## PRODIDOMIDÆ.

32. *Zimiris pubescens*, sp. nov.

PLATE XIII, FIG. 3.

Length ♀ 3.8 mm. Cephalothorax, legs, and sternum pale yellowish; abdomen pale grayish; A. M. E. surrounded by a black spot. Cephalothorax nearly once and a half as long as broad, not much narrowed in front, low, dorsal groove short; clypeus narrow, clothed with some scattered black hairs; A. M. E. smaller than other eyes, distinctly separated from each other and from A. S. E.; S. E. touching; P. M. E. oval, touching each other and P. S. E.; mandibles quite large and stout, somewhat porrect and diverging, fang long and slender. Palpi and legs quite thickly clothed with long hairs; femora thickened; tarsus II as long as metatarsus; femur III with one spine above, a few under tibia and some at apex of metatarsus. Sternum oval, one-fourth longer than broad. Abdomen nearly twice as long as broad, clothed with short, gray hair; inferior spinnerets much larger but barely longer than superior pair, with a bundle of long tubules at tip arising a little in front of inferior pair. Epigynum of two small holes about their diameter apart, from which extends behind an outline like a comma, and in front an outline of an inverted comma.

One specimen, without locality.

33. *Zimiris griseus*, sp. nov.

PLATE XIII, FIG. 4.

Length 3.2 mm. (young). Cephalothorax, bases of femora, and abdomen gray; rest of legs and palpi yellowish; A. M. E. surrounded by a black spot.

Cephalothorax about one-fourth longer than broad, considerably narrowed in front, clothed with appressed hair, dorsal groove short; A. M. E. smaller than others, separated from each other by almost their diameter, not half so far from A. S. E.; S. E. touching; P. M. E. oval, touching P. S. E., but separated from each other by fully their transverse diameter; mandibles stout, slightly porrect, strongly diverging, a row of long hairs with curved tips on their superior margin; sternum but little longer than broad. Legs quite large and long; femur II about as long as the cephalothorax; tarsus plainly shorter than metatarsus (legs I and IV lacking), clothed with quite long hair. Abdomen depressed, short and broad, once and a third longer than broad; inferior spinnerets very much longer and larger than superior pair, with a long bundle of tubules at the tip, they arise from the venter, one-third the distance from tip to base.

One specimen; no locality.

## DRASSIDÆ.

### 34. *Drassus singularis*, sp. nov.

PLATE XIII, FIG. 8.

Length 10 mm. Cephalothorax, mandibles, and sternum reddish brown, legs paler at base, darker toward the tips; abdomen brown above, paler at base and on venter. Cephalothorax moderately slender; posterior eye-row longer than the anterior row, slightly procurved; P. M. E. round, fully their diameter apart, hardly farther from the P. S. E.; A. M. E. large, nearly their diameter apart, very much closer to the smaller A. S. E.; sternum one and one-fourth times as long as broad, sides rounded. Abdomen one and two-thirds longer than broad, depressed. One spine under tips of tibiae I and II, two under bases of those metatarsi, many on hind legs, one above on tibia III; scopulas on anterior tarsi. The epigynum shows a cavity broader than long, anterior corner extending forward, and within on each posterior side is a deeper cavity.

One female; Mt. Orizaba.

### 35. *Drassus orizaba*, sp. nov.

PLATE XIII, FIG. 11.

Length 9 mm. Cephalothorax dark yellow-brown, darker in front; mandibles dark red-brown; legs bright reddish yellow; sternum and mouth-parts red-brown; abdomen light brownish. Cephalothorax rather slender; posterior eye-row nearly straight, plainly longer than anterior row; P. M. E. oval, less than half their diameter apart, more than their diameter from the P. S. E.; A. M. E. less than diameter apart, much closer to the equal A. S. E.; mandibles large and porrect; sternum one and one-fourth as long as broad, broad at base, tapering behind. Abdomen large, cylindrical, about twice as large as broad. Legs short, no spines under anterior pairs, many on

posterior ones, one above on tibia III. The epigynum shows a cavity longer than broad, anterior part almost wholly occupied by the broad septum, which is narrowed near the middle and with several fine teeth at tip.

One female; Mt. Orizaba.

### 36. *Drassodes perditus*, sp. nov.

PLATE XIII, FIG. 7.

Length ♂ 10 mm., ♀ 12 mm. Cephalothorax reddish brown, clothed with white pubescence; legs yellow, tips darker; sternum reddish; mandibles dark red-brown; abdomen gray, with a basal horny spot, reaching one-third of way to tip on dorsum, mostly clothed with black hair. Posterior eye-row slightly procurved, longer than the anterior row; P. M. E. round, nearly their diameter apart, plainly farther from the equal P. S. E.; the anterior row straight; A. M. E. larger, about one-half their diameter apart, much closer to the A. S. E.; lateral eyes separated by more than their diameter; sternum broad, sides rounded. Legs moderately long, three pairs of spines under anterior tibiae, one pair under base of anterior metatarsi; posterior pairs spined on all sides; scopulas on anterior legs to the bases of metatarsi. Abdomen rather depressed, about twice as long as broad. Tibia of male palpus about as long as broad, with a bifid projection on the outer tip, the inner branch short and stout, the outer longer and sickle-shaped; tarsus short, the bulb very large and long, quite simple, with a small pale portion at tip. The female is much like the male, but rather darker, and under tibiae I one spine at base, one at middle, and a pair at tip. Epigynum shows a simple triangular cavity, longer than broad, and deepest behind; two dark, curved marks in front.

Two males from Agua Caliente and a female from Mexico City.

### 37. *Leptodrassus* (?) *incertus*, sp. nov.

PLATE XIII, FIG. 10.

Length 7 mm. Cephalothorax red-brown in front, fading to pale yellowish behind; mandibles dark red-brown; sternum reddish; legs yellowish; abdomen uniform light gray. Cephalothorax once and a third as long as broad, broad in front; posterior eye-row nearly straight; P. M. E. round, nearly twice their diameter apart, about as far from the slightly larger P. S. E.; anterior row recurved; A. M. E. large, less than their diameter apart, closer to the smaller A. S. E. which almost touch the P. S. E.; mandibles very large, porrect, convex, granulate above, three teeth in front of fang, five small ones behind; maxillae show no transverse furrow, but rather convex; lip nearly square; sternum one-fourth longer than broad, nearly as broad in front as in the middle. Legs rather slender, no spines above on the tibiae, five pairs below on tibia I, three pairs on tibia IV, two pairs under metatarsus I, three pairs under metatarsus IV; at tip of metatarsus IV is a bunch of black hair;

a dense fascicle of hair under the claws. Abdomen rather cylindrical; spinnerets short, close together. The epigynum shows two large dark spots and between them a narrow furrow open in front.

One female; San José del Cabo, Sept. It differs from the genus in having larger, more toothed mandibles, and shorter spinnerets.

**38. *Prosthesima grisea*, sp. nov.**

PLATE XIII, FIG. 33.

Length 7 mm. Cephalothorax, mandibles, legs, and sternum pale reddish brown; the legs rather more yellowish; abdomen above and below dark gray. Cephalothorax rather broad, considerably narrowed in front; posterior eye-row straight; the P. M. E. oval, about one-half their diameter apart, rather farther from the equal P. S. E.; anterior eye-row about as long as the posterior one, procurved; A. M. E. scarcely their diameter apart, closer to the equal A. S. E.; sternum longer than broad, truncate in front, sides rounded. Legs rather short and stout, no spines under leg I, one under tibia II, and two under metatarsus II, many on hind pairs but not above on tibiae. Abdomen depressed, truncate at base, blunt pointed behind. The epigynum shows a rounded cavity with a triangular median extension in front.

One specimen; Cape Region.

**39. *Prosthesima peninsulana*, sp. nov.**

PLATE XIII, FIG. 16.

Length 8 mm. Cephalothorax, mandibles, and sternum bright reddish brown; legs rather paler; abdomen blackish, paler below. Posterior eye-row straight, barely longer than anterior row; P. M. E. large, oval, almost touching, but little farther from the P. S. E.; anterior row procurved; A. M. E. about one-half their diameter apart, closer to the hardly larger A. S. E.; sternum oval. Abdomen once and a half longer than broad, truncate at base, depressed. Legs moderate, no spines under tibia and metatarsus I, but many short stiff bristles; many spines on hind legs. Epigynum shows a somewhat triangular cavity indented by two slender projections from behind.

One example; no locality except Baja California.

**40. *Prosthesima mexicana*, sp. nov.**

PLATE XIII, FIG. 18.

Length 6–8 mm. Cephalothorax and mandibles reddish yellow; legs and sternum paler; abdomen red-brown above, paler beneath. Cephalothorax moderately slender, much narrowed in front; eyes close together; the posterior row slightly procurved; the P. M. E. somewhat oval, less than one-half



their diameter from each other, distinctly farther from the rather smaller P. S. E.; A. M. E. fully one-half their diameter apart and closer to the equal A. S. E.; sternum rather oval, tapering and pointed behind. Legs moderate; no spine under tibiae I, one under middle of tibiae II, two under base of metatarsi I and II; the posterior pairs with more spines, but none above on the tibiae. Abdomen subcylindrical, hardly depressed, nearly twice as long as broad. The epigynum shows a cavity somewhat triangular, with hardly rounded corners, and with a tooth on the superior side, divided by a septum, broadest near base, then gradually tapering toward tip, where it is somewhat enlarged.

Several examples from Orizaba, and Mt. Orizaba, Jan. A small specimen from Mexico City shows the epigynum rather broader, but of the same general character.

#### 41. *Prothesima gentilis*, sp. nov.

PLATE XIII, FIG. 17.

Length 3.3 mm. Cephalothorax, mandibles, sternum, and legs dull yellowish; abdomen gray, mostly clothed with black hair, more prominent at the base of abdomen. Cephalothorax low, much narrowed in front, dorsal groove short; posterior eye-row straight; P. M. E. round, less than one-half their diameter apart, distinctly farther from the nearly equal P. S. E.; A. M. E. barely smaller, close together, not farther from the nearly equal A. S. E.; sternum once and a fourth longer than broad, sides rounded. Abdomen depressed, truncate at base. Legs short, apparently no spines under tibiae I and II, quite a number below and on sides of posterior pairs. The epigynum shows an angulated area longer than broad, narrowed in front, and divided by a dark line; behind are two dark oval bodies.

One specimen from La Chuparosa.

#### 42. *Prothesima fidelis*, sp. nov.

PLATE XIII, FIG. 19.

Length 3.6 mm. Cephalothorax, mandibles, sternum, and legs dull yellowish; anterior patellae and tibiae darker above; abdomen dark gray above, lighter beneath, clothed with black hair rather more thickly than in *P. gentilis*. Cephalothorax low, quite slender, dorsal groove short; posterior eye-row straight, about as long as the anterior row; P. M. E. round, close together, a little farther from the equal P. S. E.; A. M. E. close together and as close to the equal A. S. E.; sternum oval, rather broader than in *P. gentilis*. Abdomen depressed, truncate at base, broadly rounded behind. Legs short, no spines below anterior tibiae, a few on the metatarsus; posterior pairs numerous spined; weak scopulas on anterior tarsi. The epigynum shows a nearly square area bounded, except behind, by a black ridge and divided by two median lines; behind on each side is a dark opening on the margin of an obscure mark.

One female from Minititlan, Feb. 3, 1892. (Bruner coll.). Closely related to *P. gentilis*, but separated by shape of epigynum, and darker anterior tibiae and patellae.

**43. *Prothesima atra* Hentz.**—Three specimens from the Cape Region of Baja California. They are not so black as eastern specimens, but as dark as those from Washington State. The epigynum is a large opening, narrowed behind, but not sufficient to consider as a distinct species, but rather a geographical race.

**44. *Prothesima directa*, sp. nov.**

PLATE XIII, FIG. 21.

Length 7.5 mm. Cephalothorax shining yellowish; legs and sternum similar; mandibles more reddish; abdomen pale grayish, with four impressed dark dots above, and a basal, horny shield reaching half way to the middle of dorsum. Cephalothorax moderately slender; posterior eye-row slightly procurved; P. M. E. hardly round, scarcely their diameter apart, and about as far from the equal P. S. E.; anterior row straight or barely recurved; A. M. E. large, less than their diameter apart, and not so far from the A. S. E.; mandibles scarcely correct; sternum once and a third longer than broad, narrowed in front and behind. Legs moderately long; three pairs of spines under the anterior tibiae, and one pair under the base of anterior metatarsi; posterior pairs numerous spined; anterior tarsi with fine scopulas. Abdomen hardly depressed, twice as long as wide; spinnerets long, the superior pair two-thirds as long as inferior pair. The  $\delta$  palpus has the tibia a little longer than broad, and a slender spine-like projection at the outer tip, the bulb long and quite simple, at the end a pale part with a fine short tip.

One  $\delta$  from La Chuparosa. Related to *P. valida* Bks., from California, but readily separated by having a straight (instead of curved) projection at tip of the tibia of  $\delta$  palpus.

**45. *Prothesima completa*, sp. nov.**

PLATE XIII, FIG. 22.

Length 7 mm. Cephalothorax yellowish; legs similar, paler at base; mandibles and sternum more reddish; abdomen paler grayish; clothed with black hair, most prominent at the base of abdomen, a horny shield at base, but hardly extending upon the dorsum. Posterior eye-row nearly straight; the P. M. E. slightly oval, hardly one-half their diameter apart, a little further from the equal P. S. E.; A. M. E. smaller, nearly their diameter apart and much closer to the A. S. E.; mandibles scarcely correct; sternum oval, rather

broad in front; abdomen slightly depressed, twice as long as wide. Legs quite long, no spines under tibia or metatarsus I, one under tibia II, three under metatarsus II; posterior pairs numerous spined; scapulas very thin and scanty. Tibia of  $\delta$  palpus about as long as broad, with a large, stout projection at outer tip; tarsus short, the bulb large, but little modified and with a short, stout black tube at the tip. The  $\varphi$  resembles the  $\delta$ ; abdomen broader, no horny spot at base, and no spine under tibia II. The epigynum shows a triangular opening with the corners rounded, and behind two round dark marks.

A male from La Chuparosa and the female from San José del Cabo. Readily separated from *P. directa* by shape of  $\delta$  palpus and less spiny anterior legs.

#### 46. *Prothesima indecisa*, sp. nov.

PLATE XIII, FIG. 20.

Length 7 mm. Cephalothorax, legs, mandibles, and sternum yellow-brown; abdomen dark gray, paler below, with a triangular horny shield at base. The cephalothorax is considerably narrowed in front; the posterior eye-row straight; P. M. E. round, less than their diameter apart, about that distance from the equal P. S. E.; A. M. E. about their diameter apart, much closer to the rather larger A. S. E.; sternum but little longer than broad, sides rounded. Legs short, no spines under the anterior tibiae, one under metatarsus II, many on the posterior legs; coxae of first legs considerably longer than the others. Abdomen once and two-thirds as long as broad, truncate at base. The  $\delta$  palpus has the tibia about as broad as long, with a straight, stout projection at outer tip; the bulb is quite large and shows a curved tube at the tip.

One male from San Miguel de Horcasitas.

#### 47. *Megamyrmeleon californicum* Sim.

PLATE XIII, FIG. 25.

Several specimens from Sierra San Lazaro, Sept., and from La Chuparosa.

#### 48. *Cesonia trivittata*, sp. nov.

PLATE XIII, FIG. 23.

Length 5 mm. Cephalothorax pale yellowish, with a black stripe each side, and a black seam; legs, sternum, and mandibles pale yellowish; abdomen whitish, with three black stripes above, one on each side reaching to the spinnerets, and one in the middle usually ending before the tip, but in one young specimen connected at tip with the side stripes; venter with two indistinct dark stripes. Cephalothorax slender; posterior eye-row about straight;

P. M. E. separated by once and a half their diameter, less than diameter from P. S. E.; anterior row rather recurved; A. M. E. hardly their diameter apart and closer to the rather smaller A. S. E. Legs short, a spine under patella I, three or four under tibia I, and one under base of metatarsus I; posterior legs more thickly spined. Sternum once and a fourth longer than broad, tapering in front and behind. Abdomen once and three-fourths longer than broad, truncate at base; spinnerets very long. The epigynum shows only a nearly circular cavity, and the outline of two bodies toward the front and a line each side.

A few specimens from Sierra San Lazaro, Sept. It is readily separated from *C. bivittatus* Hentz. by the three stripes on abdomen, its smaller size, and by its more slender body.

#### 49. *Cesonia mexicana*, sp. nov.

PLATE XIII, FIG. 24.

Length ♂ 6 mm. Cephalothorax dark brownish, with a narrow median white stripe, and a stripe each side; legs yellowish brown, tinged with blackish; sternum and mandibles brown; abdomen white above, with a black stripe each side and a broader one in the middle, all reaching to the tip; venter brownish; mostly clothed with black hair. Cephalothorax quite broad, much narrowed in front; eyes about as in preceding species; sternum very broad and rounded; abdomen narrow, a long horny shield at base. Legs of moderate length, three pairs of spines under tibia I, one under base of metatarsus I, posterior pairs thickly spined; tibia of ♂ palpus short, with a long slender slightly curved projection at the outer tip; tarsus short, with a long, dark, simple bulb and beyond a small pale portion. The ♀ is 7 mm. long, agrees with ♂ in color and markings, has no horny shield at base of abdomen which is broader. The epigynum shows two holes about their diameter apart.

Male from Mt. Orizaba; female from Tepic, Nov. It is distinguishable from *C. bivittatus* Hentz. by its three stripes on abdomen, by darker color, and by the more curved projection to tibia of ♂ palpus. It differs from the preceding species principally in broader cephalothorax, larger size, darker color, and shape of epigynum.

#### 50. *Gnaphosa decepta*, sp. nov.

PLATE XIII, FIG. 14.

Length ♀ 7 mm. Cephalothorax, legs, and sternum bright yellowish brown, the former with some blackish marks around the dorsal groove, and the tarsi of anterior legs and tips of palpi rather red-brown; mouth-parts red-brown;

abdomen uniform dark gray above and below. Cephalothorax rather short and broad; posterior eye-row slightly recurved; P. M. E. oval, less than one-half their diameter apart, fully their diameter from the P. S. E.; A. M. E. hardly their diameter apart, much closer to the equal A. S. E.; sternum nearly oval. Abdomen hardly depressed, twice as long as wide, truncate at base, and with prominent hairs. Legs of moderate length, no spines under tibiae I and II, one under base of those metatarsi, three pairs under tibia IV.

One specimen from Tepic, Nov., looks like a *Prosthesima*; related to *G. sericata* (*bicolor* Hentz.), but separated by larger and closer P. M. E. and slightly different epigynum.

### 51. *Gnaphosa distincta*, sp. nov.

PLATE XIII, FIG. 13.

Length 7-9 mm. Cephalothorax yellowish brown, sometimes more blackish, showing the usual marks; legs paler; sternum more reddish; abdomen dark gray, sprinkled with many black dots, most numerous toward tip. Cephalothorax rather broad, quite narrow in front, posterior eye-row strongly recurved; P. M. E. hardly their diameter apart, twice as far from the larger P. S. E.; the anterior row nearly straight; A. M. E. about their diameter apart, much closer to the slightly larger A. S. E.; sternum but little longer than broad, broadly truncate in front, sides rounded. Legs short, one pair of spines under tibia I at tip, two pairs under metatarsus I; posterior pairs with many spines, and one above on tibia III. Abdomen once and a half longer than broad, depressed, truncate at base. Epigynum shows two converging bodies in front of which is a short pear-shaped body.

Several examples; San José del Cabo and Sierra San Lazaro, Sept.

### 52. *Gnaphosa* (?) *abnormis*, sp. nov.

PLATE XIII, FIG. 15.

Length 10 mm. Cephalothorax, legs, mandibles, and sternum uniform dark red-brown; legs paler at tip; cephalothorax somewhat shining; abdomen light brown above and below. Cephalothorax rather slender, narrowed in front, dorsal groove quite long; mandibles with a plate behind and a striate portion in front of fang; posterior eye-row a little longer than anterior row, barely recurved; P. M. E. round, hardly their diameter apart, farther from the equal P. S. E.; A. M. E. small, about their diameter apart and closer to the very much larger A. S. E.; sternum once and a fourth longer than broad. Legs of moderate length, no spines under tibiae and metatarsi of anterior pairs; a number on posterior pairs; short, rather scanty scopulas on anterior tarsi and metatarsi. The epigynum shows a long, slender, central piece and behind two rounded humps near together.

One female; Cape Region. By the plate on mandibles it goes in the section *Gnaphosæ*, but it scarcely agrees with any genus in that section, differing in the nearly straight posterior eye-row and in the A. S. E., larger than the A. M. E.; it has not the appearance of a *Gnaphosa*.

## CLUBIONIDÆ.

### 53. *Anyphæna futilis*, sp. nov.

PLATE XIII, FIG. 31.

Length ♀ 7 mm., ♂ 5 mm. Cephalothorax yellowish, with indications of a darker stripe each side; eyes on black spots; mandibles dark red-brown; sternum and legs pale yellowish, little darker at tips and a band on the tip of hind tibia; abdomen yellowish, with two brownish stripes above, converging at the tip. Cephalothorax short and broad; posterior eye-row procurved; P. M. E. once and a half their diameter apart, rather closer to the equal P. S. E.; anterior row shorter, nearly straight, not much smaller than the posterior eyes; A. M. E. less than their diameter apart, closer to the nearly equal A. S. E.; mandibles long, strongly porrect, slightly divergent; sternum narrowly oval. Legs rather long with many spines, none above on tibia I; tibia plus patella I about equal to the same joints of leg IV; metatarsus IV, however, much longer than that of I in the ♀, in ♂ shorter. Abdomen nearly twice as long as broad, furrow much nearer to epigynum than to spinnerets. Epigynum shows a large cavity, much broader than long, bordered by red. The ♂ palpus has the tibia twice as long as broad, with a long, slender, black projection on the outer tip; the tube is long and slender, the point lying in a furrow near the tip of the tarsus; a long, slender piece curved around the palpal organ, and a pale transverse area at base.

Two specimens and young; San José del Cabo and Sierra San Lazaro.

### 54. *Gayenna orizaba*, sp. nov.

PLATE XIII, FIG. 37.

Length ♀ 7 mm. Cephalothorax, mandibles, and legs yellowish, eyes on black spots; sternum pale; abdomen pale with many fuscous dots, rather more numerous behind. Cephalothorax short; the posterior eye-row straight or slightly procurved; P. M. E. much more than their diameter apart, hardly as far from the equal P. S. E.; anterior eyes smaller, close together; A. M. E. smaller than A. S. E.; mandibles vertical; sternum oval. Legs short, all spined; tibia plus patella I plainly longer than those joints of leg IV. Abdomen large, once and a half longer than broad, furrow nearer to the spinnerets than to the epigynum. Epigynum shows two small holes about their diameter

apart, and two oblong, dark spots in front, and a dark central spot before these.

One female; Mt. Orizaba.

**55. *Gayenna ignava*, sp. nov.**

PLATE XIII, FIG. 34.

Length 5.5 mm. Cephalothorax and mandibles dull yellowish; eyes on black spots; legs and sternum paler; abdomen gray, indistinctly mottled. The cephalothorax is short, considerably narrowed in front; posterior eye-row nearly straight; P. M. E. fully their diameter apart, rather closer to the P. S. E.; anterior row shorter, eye smaller, nearly equal and close together; mandibles hardly porrect; sternum narrowly oval. Legs moderately long, with long spines; tibia plus patella I shorter than those joints of leg IV. Abdomen once and two-thirds longer than broad, furrow about half way between spinnerets and epigynum. The latter shows a cavity longer than broad, narrowed behind, and containing two lobes in front.

One female; no locality.

**56. *Gayenna minuta*, sp. nov.**

PLATE XIII, FIG. 32.

Length ♀ 3.6 mm. Cephalothorax pale yellowish, with faint traces of darker stripes, slightly blackened around eye region; eyes on black spots; mandibles black; legs, sternum, and abdomen whitish, the latter rather yellowish on each side above toward the tip. Cephalothorax about as long as tibia plus patella I; P. M. E. once and a half their diameter apart, plainly closer to the equal P. S. E.; anterior eyes smaller; A. M. E. about their diameter apart, rather closer to the larger A. S. E. Legs rather short, with scattered spines; tibia plus patella I about equal to tibia plus patella IV; sternum once and a half longer than broad, tapering in front and behind. Abdomen nearly twice as long as broad, rounded in front, pointed at tip; ventral furrow half way between epigynum and spinnerets. Epigynum shows a dark curved mark each side behind, and in front each side an elliptical hole bordered with dark.

One female; Tepic, Oct.

**57. *Chiracanthium parvulum*, sp. nov.**

PLATE XIII, FIG. 36.

Length ♂ 2.7 mm. Cephalothorax, mandibles, and sternum pale yellowish; abdomen and legs whitish. Posterior eye-row procurved; P. M. E. once and a half their diameter apart, rather closer to the slightly smaller P. S. E.;

anterior row straight; A. M. E. about diameter apart, closer to the equal A. S. E.; mandibles quite large and stout, scarcely porrect. Legs long, with long spines; first pair longest; hind femora rather stout. Abdomen narrow and cylindrical; ♂ palpus very large; tibia curved, with a large projection on the outer side from near the base, trifid at tip.

One male; Sierra San Lazaro, Sept. Its small size and the trifid projection to the tibia of palpus separate it from the allied *C. albens* Hentz.

**58. *Chiracanthium inclusa* Hentz.**—Several specimens from San José del Cabo, and Tepic, Oct.

**59. *Trachelas parvulus*, sp. nov.**

PLATE XIII, FIG. 28.

Length 4.5 mm. Cephalothorax, mandibles, and sternum dark red-brown; legs all pale yellowish; abdomen dark brown, paler beneath. Cephalothorax and sternum rugulose; posterior eye-row but slightly recurved; the P. M. E. round, hardly their diameter apart and about as far from the equal P. S. E.; anterior row a little shorter, straight; A. M. E. equal to the P. M. E., a little less than their diameter apart, much closer to the equal A. S. E.; mandibles not porrect; sternum once and a third longer than broad, truncate at base. Legs slender, clothed with fine hair, no spines. Abdomen once and a half longer than broad, rounded at base, pointed at tip. The epigynum shows a cavity much broader than long, in each hind corner a darker spot, and two long dark bodies are outlined in front.

One female; no locality. Readily separated from *T. speciosa* by its smaller size, much shorter and straighter posterior eye-row, and different epigynum, as well as the pale front legs.

**60. *Trachelas speciosa*, sp. nov.**

PLATE XIV, FIG. 32.

Length 5.5 to 8.5 mm. Cephalothorax, mandibles, and sternum dark red-brown; anterior pair of legs reddish, others pale yellowish; abdomen dark gray or brownish, four red-brown impressions above. Cephalothorax, mandibles, and sternum finely rugulose; head broad; posterior eye-row strongly recurved; P. M. E. round, once and two-thirds their diameter apart, more than twice their diameter from the equal P. S. E.; anterior row much shorter, nearly straight; A. M. E. equal to P. M. E., about their diameter apart, much closer to the equal A. S. E.; mandibles very stout, slightly porrect; sternum once and a half longer than broad, truncate in front, sides rounded. First pair of legs stout, all clothed with fine hair, no spines. Abdomen once



and a half longer than broad, rounded at base, pointed behind. The epigynum shows two dark cavities separated by a narrow septum, and behind two pale cavities, in front are outlined two dark bodies. The  $\delta$  palpus is similar to that of *T. tranquilla* Hentz., but the bulb is longer.

Several specimens; Magdalena Island and El Taste. A young one is pale colored on the thorax and front legs, like allied species.

#### 61. *Trachelas mexicana*, sp. nov.

PLATE XIII, FIG. 27.

Length 8 mm. Cephalothorax, mandibles, and sternum bright red-brown; first legs rather paler, others yellowish; abdomen gray, darker toward the tip. Cephalothorax and sternum finely rugulose like *T. tranquilla*; posterior eye-row strongly recurved; P. M. E. about once and a half their diameter apart (two and a half times in *T. tranquilla*), more than twice their diameter from the equal P. S. E.; A. M. E. less than their diameter apart, rather closer to the A. S. E.; mandibles large, not so prominent as in *T. tranquilla*; legs with fine hairs, no spines; sternum like that of *T. tranquilla*; and abdomen as in that species. The epigynum shows two holes as in that species, but the corneous area extends further forward.

One female from Tepic, Oct. Closely related to *T. tranquilla*, but light cephalothorax, smaller size, and position of posterior eyes proclaim it distinct.

#### 62. *Clubiona complicata*, sp. nov.

PLATE XIII, FIG. 39.

Length of ceph. 5 mm., broad in middle 4.4 mm., front 2 mm.; tibia plus patella 16 mm. Cephalothorax, legs, mandibles, and sternum pale yellowish; legs more reddish on the metatarsi; abdomen pale gray above and below. Cephalothorax rather broad and low; posterior eye-row straight, about equal in size; the P. M. E. their diameter apart, more than twice as far from the P. S. E.; eyes of anterior row at about equal distances; the A. M. E. smaller and scarcely their diameter apart; legs large and long, two spines above on all tibiae, six pairs below on tibia I; sternum a little longer than broad, concave in front, sides rounded; abdomen small and short; patella of  $\delta$  palpus as long as the tibia, the latter with a large forked projection on the outer side, the outer branch of which is curved and bifid at tip.

One male from San José del Cabo.

63. *Syspira tigrina* Sim.—Several specimens; San José del Cabo, Mazatlan, and Hermosillo.

64. *Syspira longipes* Sim.—A few specimens, about 10 mm. long, from San José del Cabo, seem to be this species.

65. *Corinna peninsulana*, sp. nov.

PLATE XIII, FIG. 26.

Length 6 mm.; ceph. 3 mm. long, broad 2.4 mm.; tibia plus patella IV 3.6 mm. Cephalothorax red-brown, almost black in the eye-region; mandibles dark red-brown; sternum red-brown; legs reddish or yellowish brown; abdomen dark gray or blackish, darkest above; cephalothorax clothed with fine short white hair. Cephalothorax rather broad, broad in front, surface, especially forward, finely granulate; anterior eye-row nearly straight; A. M. E. very large, less than one-half their diameter apart, a little farther from the slightly smaller A. S. E.; posterior eye-row barely procurved; P. M. E. small, nearly twice their diameter apart, and about as far from the equal P. S. E.; mandibles large, prominent, geniculate, granulate in front, fang long and stout; sternum very broad, nearly as broad as long, sides rounded, truncate in front. Legs moderately long and slender, with many fine short hairs and a few spines, one above on tibia IV, four pairs under tibia I, besides a short pair at tip, two pairs under metatarsus I. Abdomen slender and short, sub-cylindric, in  $\delta$  with a horny shield at base reaching above to near middle of dorsum.

A few specimens; San José del Cabo.

66. *Thargalia venusta*, sp. nov.

PLATE XIII, FIG. 35.

Length 7.5 mm.; tibia plus patella IV 3.5 mm. The cephalothorax and sternum are yellowish-red, rather blackish on the posterior sides of former; mandibles red-brown, with an elongate pale spot on the tip; anterior legs wholly pale yellowish, posterior pair darker, no bands; abdomen black, with a white band across the base, continued down upon the sides, behind a red stripe giving off, before the middle, a projection each side, which is connected to the white mark on the sides; the red stripe is terminated by a white circular mark reaching upward from the tip of abdomen. Anterior eye-row about straight; the A. M. E. nearly their diameter apart, much closer to the A. S. E.; posterior row procurved; the P. M. E. nearly once and a half their diameter apart, closer to the equal P. S. E.; sternum plainly longer than broad, truncate in front. Legs clothed with black hair; tibia plus patella IV a little longer than cephalothorax. Abdomen nearly twice as long as broad. The epigynum shows two oval cavities, more than their diameter apart.

One specimen; San Miguel. A very pretty species.

**67. *Thargalia dorsata*, sp. nov.**

PLATE XIII, FIG. 30.

Length 9-10 mm.; tibia plus patella IV 4 mm. Cephalothorax, sternum, and femora black, the former clothed with white plumose hairs; all tarsi and tibiae and metatarsi of anterior pairs pale, posterior tibiae and metatarsi red-brown; mandibles black, with an elongate pale spot in front near the tip; abdomen black, a small white spot at base followed by a broad red stripe, truncate before tip, sometimes on posterior part, with serrate border, on each lower side reaching forward from spinnerets is a white stripe or row of spots. Anterior eye-row nearly straight; A. M. E. about their diameter apart, much closer to the equal A. S. E.; posterior row procurved; P. M. E. nearly once and a half their diameter apart, closer to equal P. S. E. Legs very spiny, tibia plus patella IV a little longer than cephalothorax; sternum broad in front, but little longer than broad; abdomen large and broad; epigynum shows two large depressions much less than their diameter apart. The  $\delta$  is more reddish than the  $\varphi$ , and with the abdomen almost covered above with red.

Several specimens from San José del Cabo, Sierra San Nicolas, and Sierra San Lazaro, Sept. This species is close to the true *T. crocatus* Hentz., but has the sternum broader in front, the epigynum different, the red stripe above terminates farther from the tip, and there is white on the lower sides.

**68. *Thargalia mexicana*, sp. nov.**

PLATE XIII, FIG. 38.

Length 9 mm.; tibia plus patella IV 3.8 mm. The cephalothorax, femora, and sternum are red-brown, the former thickly clothed with white hair, also some on the femora, other joints of anterior legs pale yellowish, of hind pairs reddish, paler on tips of joints; mandibles red-brown, with a pale spot on the tips; abdomen dark brown, a red-brown horny shield at base extending over the basal fourth of the dorsum, clothed above with black hairs and white bands, one at base, a broader one just beyond, another before middle, and one before tip. Cephalothorax rather slender; P. M. E. a little more than their diameter apart, rather closer to the equal P. S. E.; A. M. E. less than their diameter apart, much closer to the equal A. S. E.; sternum nearly oval, not broad. Abdomen nearly twice as long as broad, punctulate above, a small, horny shield on venter just before the spinnerets. Legs with black, simple hairs and white plumose ones; tibia plus patella IV hardly as long as the cephalothorax; one spine above on tip of tibia IV.

One female; Tepic, Oct.

**69. *Thargalia gracilis*, sp. nov.**

PLATE XIII, FIG. 29.

Length 6.5 mm.; tibia plus patella IV 3 mm. Cephalothorax, sternum, and femora black, the former clothed with scattered white hairs, rest of anterior legs and last joints of palpi pale yellowish; posterior legs darker, the tibiae and metatarsi with black lines, coxae rather reddish; mandibles black, with pale spots at the tips; abdomen black, with red-brown horny shield at base extending over the basal fourth of the dorsum, some white hairs at base, and probably a band across the middle. Anterior eye-row nearly straight; A. M. E. hardly their diameter apart, closer to the A. S. E.; posterior row procurved; P. M. E. fully their diameter apart, closer to the equal P. S. E.; dorsal groove short; sternum rather broad, oval. Abdomen twice as long as wide, hardly constricted in the middle, a horny piece on venter just before the spinnerets. Tibia plus patella IV scarcely longer than the cephalothorax; a spine above on tip of tibia IV.

One female; no locality.

**70. *Hypsinotus mexicanus*, sp. nov.**

PLATE XVI, FIG. 18.

Length 10–12 mm. Cephalothorax dark red-brown, almost black in front and on the mandibles; sternum bright red-brown; legs pale yellow-brown; abdomen brown, rather paler below. Cephalothorax shining, broad, shorter than tibia plus patella I, high behind the eye-region; dorsal groove and furrows distinct; posterior eye-row procurved, P. M. E. about once and a fourth their diameter apart, and as far from the equal P. S. E.; anterior row straight; A. M. E. hardly one-half their diameter apart, about as far from the smaller A. S. E., which are about as far from the equal P. S. E.; mandibles large and prominent; sternum scarcely longer than broad. Legs quite long, having three or four pairs of spines under tibia I and II, two pairs under these metatarsi, no spines above on posterior tibiae. Epigynum shows a circular depression open behind, surrounded by a dark red-brown, horny area. Tibia of ♂ palpus has a large process with two smaller processes at the tip.

Several specimens; Tepic, Oct. and Nov.

**71. *Hypsinotus testaceus*, sp. nov.**

PLATE XVI, FIG. 17.

Length 7 mm. Cephalothorax reddish brown, testaceous behind; mandibles nearly black; sternum bright red-brown; legs pale yellow-brown; abdomen testaceous. Cephalothorax hardly shining, finely granulate, convex, broad, about as long as tibia plus patella I; dorsal groove and furrows distinct; posterior eye-row procurved; P. M. E. fully once and a third their diameter apart, rather farther from the equal P. S. E.; A. M. E. much larger,

one-half their diameter apart, closer to the smaller A. S. E.; the mandibles large and prominent. Legs not very long, hairy, six pairs of spines under the anterior tibiae, and two pairs under these metatarsi, two above on the hind tibia; sternum hardly longer than broad; tibia of  $\delta$  palpus has above two processes at the tip, the upper one much broader than the other.

One male; Tepic, Oct.

## AGALENIDÆ.

72. *Tegenaria derhami* Scop.—One female; La Chuparosa.

73. *Tegenaria californica* Banks.—Several specimens; without locality.

74. *Tegenaria modesta*, sp. nov.

PLATE XIV, FIG. 21.

Length 8.5 mm.; femur I 5 mm. Cephalothorax dull yellowish, indistinctly mottled with dark, seam black; eyes on black spots; legs yellowish, with indistinct darker bands; mandibles reddish; sternum brown, paler in front; abdomen gray, above and on sides with a net-work of dark lines; venter with a white line each side. Cephalothorax not very long; posterior eye-row slightly procurved; lower row straight; P. M. E. their diameter apart, farther from the P. S. E.; A. M. E. smaller. Legs long and slender, femur I much longer than cephalothorax; sternum as broad as long, narrowly prolonged between the hind coxæ. Apical joint of the superior spinnerets shorter than the basal joint. The epigynum shows a shield-shaped cavity in front, a long median line behind ending in a small transverse cavity.

One specimen; without locality.

75. *Tegenaria obscura*, sp. nov.

PLATE XIV, FIG. 26.

Length 6.5 mm.; femur I 3 mm. Cephalothorax yellowish, with two indistinct dark stripes, seam black; eyes on black spots; legs yellowish, indistinctly banded; mandibles reddish; sternum blackish, with a pale central line and spots on the side; abdomen thickly covered with blackish marks, leaving in front a pale spear-mark, and on each side two pale oblique spots; venter rather paler. Cephalothorax rather slender; posterior eye-row slightly procurved; anterior row straight; P. M. E. about their diameter apart, farther from the equal P. S. E.; A. M. E. smaller. Legs rather short, femur I about as long as the cephalothorax; sternum longer than broad, pointed between

the hind coxæ. Apical joint of the superior spinnerets slender, rather longer than basal joint. Epigynum shows a transverse, rounded cavity nearly filled by a broad, rounded plate.

One example; San Miguel de Horcasitas.

**76. *Agalena pacifica* Banks.**—One male; no locality.

**77. *Agalena peninsulana*, sp. nov.**

PLATE XIV, FIG. 22.

Length ♀ 7–9 mm. Cephalothorax yellowish, with brown stripe each side and a black marginal seam; the mandibles more reddish; legs yellowish, with black bands and spots; abdomen brown, with a median yellowish stripe, dentate behind and margined with black; spinnerets reddish; venter gray; sternum dark, with a pale central stripe and side-spots. P. M. E. about once their diameter apart, full as far from the P. S. E. Last joint of the superior spinnerets rather longer than the basal joint, but not as long as in *A. californica*. The epigynum consists of a cavity broader than long, divided by a triangular septum, widest behind.

Three specimens from La Chuparosa. It differs from *A. californica* in the epigynum, spinnerets, and markings of the sternum.

**78. *Agalena orizaba*, sp. nov.**

PLATE XIV, FIG. 30.

Length ♀ 9 mm. Cephalothorax and legs rather reddish yellow, faint traces of marks on the former; abdomen grayish, rather uniformly finely netted with brown and a pale stripe above, dentate behind and margined with blackish spots; spinnerets pale; venter brownish; sternum yellow-brown; mandibles red-brown. P. M. E. less than diameter apart, as far from the P. S. E. Last joint of the superior spinnerets shorter than the basal one. The epigynum has a transverse bridge somewhat like that of *A. navia*, at end of which there is a black mark.

One female; Mt. Orizaba.

**79. *Cœlotes exaptus*, sp. nov.**

PLATE XIV, FIG. 27.

Length ♀ 8–10 mm. Cephalothorax reddish, darker on the head and on the mandibles; sternum reddish; legs rather paler, uniform; abdomen above and below pale grayish. Cephalothorax rather short, a little shorter than

tibia plus patellæ I; A. M. E. hardly their diameter apart, rather larger than the A. S. E.; P. M. E. much smaller, about three times their diameter apart and farther from the larger P. S. E.; mandibles strongly geniculate; sternum scarcely longer than broad, somewhat narrowed in front. Legs moderate, five pairs of spines under tibia I, two pairs under metatarsi I, two above on tibia IV. Epigynum shows a transverse, rounded corneous plate, emarginate in front, and two dark cavities behind.

Three specimens; San Francisquito and El Taste.

## DICTYNIDÆ.

### 80. *Amaurobius peninsulanus*, sp. nov.

PLATE XIV, FIG. 23.

Length ♀ 10 mm., ♂ 8.5 mm. Cephalothorax reddish, blackish around eye-region; mandibles dark red-brown; legs and sternum yellowish; abdomen brownish, darker above; the ♂ shows a pale spot at base. P. M. E. about two and a half times their diameter apart, much farther from the P. S. E.; mandibles large, prominent at base. Legs rather short, much longer in the ♂, especially the first pair; three pairs of spines under the tibia I in ♀, more numerous in ♂. The epigynum shows an elevated part each side, separated by a smaller and shorter middle piece. The tibia of the ♂ palpus has two large projections, one spreading with a sharp point, the other erect and blunt at tip. Two smaller projections just below the insertion of the tarsus, the latter is short and curved, with a large palpal organ.

Male and female from San José del Cabo.

### 81. *Dictyna avara*, sp. nov.

PLATE XIV, FIG. 19.

Length 5 mm. Cephalothorax dark red-brown, darkest near the eye-region; mandibles same color; sternum brownish; legs paler, more yellowish, except the anterior femora, which are almost red-brown, covered with white and black hairs; abdomen whitish, sparsely clothed with blackish hair, forming a faint, irregular, central folium, and a stripe each side. Cephalothorax rather broad. Abdomen very large, once and a half longer than broad. Epigynum has the inner outline of the anterior cavities continuous with the posterior ones.

One female; no locality.

82. *Dictyna sublata* Hentz.—Three specimens from San José del Cabo.

83. *Dictyna miniata*, sp. nov.

PLATE XIV, FIG. 25.

Length ♂ 3.6 mm. Cephalothorax pale reddish, paler behind; eyes on dark spots; mandibles reddish; legs and sternum yellowish; abdomen gray, darker above, with traces of pale chevrons. Pars cephalica high, much narrower in front; mandibles long, bowed, concave, faintly granulate; legs long and slender, with black hairs, first pair much the largest; sternum nearly as broad as long, scarcely narrowed in front; abdomen about twice as long as broad, pointed behind; palpi stout; tibia very short and with a short tooth above; tarsus slender with a long process around it bearing the style.

One male; Guaymas.

84. *Dictyna texana* Banks. — Two specimens from Tepic.

85. *Dictyna*, sp.? One specimen, no locality, with a manuscript name by Dr. Marx, but it is not adult so I shall not venture to describe it. It has a light marginal stripe on the cephalothorax.

86. *Altella polita*, sp. nov.

PLATE XIV, FIG. 20.

Length 4.5 mm. Cephalothorax and mandibles reddish, blackish around the eyes; sternum rather yellowish brown; legs similar, except the patellæ which are paler; abdomen dark gray above, with two rows of pale spots in the posterior part, below lighter gray. Cephalothorax rather low, but little elevated in the pars cephalica; anterior eye-row straight; A. M. E. smaller than A. S. E., scarcely their diameter apart; posterior row slightly procurved; P. M. E. once and a half their diameter apart, as far from the equal P. S. E.; mandibles geniculate at the base; sternum plainly longer than broad, sides rounded, pointed behind. Legs rather short, with many hairs, one spine below on metatarsus I and II, three below near tip of tibia III, one at middle and two at the tip of tibia IV, several on the posterior metatarsi. Abdomen twice as long as broad, rounded at base, scarcely pointed at the tip, slightly depressed. The epigynum shows each side a dark curved mark, and in front a pale round opening.

One female; no locality. The genus differs from *Dictyna* in having spines on the legs, and in the smaller A. M. E.



## ULOBORIDÆ.

87. *Uloborus plumipes* Luc.—One specimen from Tepic looks very much like the Texan example of this species, very much darkened all over; the metatarsus I pale; tibia and femur I black.

88. *Uloborus formosus* Marx ms.

PLATE XIV, FIG. 31.

*Female* 5 mm. long.

Cephax. long 1.5, broad in front .8, broad in middle 1.3.

Abdomen long 4, broad 2.2, high at the hunches 2.5.

Femur I 2.5, pat.+tibia 2.6, metat. 2, tars. 1.1

II	1.5	1.5	1.1	.7
----	-----	-----	-----	----

III	1.2	1.1	.8	.8
-----	-----	-----	----	----

IV	2.	2.	1.2	1.
----	----	----	-----	----

Cephalothorax brown, with a short but broad, light grayish middle line over the posterior part of pars cephalica, and two oval dots at the thoracic part. Mandibles brownish yellow; maxillæ blackish brown; labium black, with a white tip; sternum blackish brown with dense black hairs; coxæ light grayish white, with a black spot in the center. Legs, 1st pair, femur brownish, infuscated, with a whitish ring just beyond the middle; patella infuscated; tibia infuscated, with a white ring at the base and near the distal end; metatarsus and tarsus dark infuscated toward the end; 2nd leg, femur light grayish white, with three dark rings, one at the base, the other near middle, and the third at tip; tibia with a band at middle and one at tip; metatarsus and tarsus of the same ground color and infuscated at tips; legs 3 and 4 of the same color and markings as leg 2, only the metatarsi with a ring near middle and one at tip. Abdomen, dorsal surface gray with a whitish center, which is interrupted by a dark gray middle line, which reaches over the basal half; the sides blackish; and at the under side behind the fold white with a square black spot, with two longitudinal white lines near the sides, and behind this with black diverging lines which run toward the black spinnerets.

Cephalothorax slightly longer than broad; the mouth-parts similar to those in the other species; sternum narrow and long; abdomen elevated by a protuberance which gives the dorsum an angular aspect.

One female; Orizaba.

89. *Uloborus diversus* Marx ms.

PLATE XV, FIG. 17.

Cephax. long 1.5, broad in middle 1.2, broad in front .6 mm.

Abdomen long 4., thick at the hunch 2.5.

Femur I 2., pat.+tibia 2., meta. 1.7, tarsus .6

II	1.2	1.2	.7	.5
----	-----	-----	----	----

III	1.	.8	.6	.5
-----	----	----	----	----

IV	1.3	1.5	1.	.7
----	-----	-----	----	----

Cephalothorax dark brown, covered with a rather long, reddish brown pubescence, and especially at the sides, behind pars cephalica with white hairs, in the posterior part at base with a triangular yellow spot. Mandibles and maxillæ brownish yellow, the latter at the inner sides pale; labium at base yellowish, whitish at tip; sternum yellowish brown with a black border. Legs 1st pair, femur and patella dark brown, the other joints light yellow, with the distal end dark infuscated, apical half of metatarsus deep black, sometimes a pale spot on femur beyond the middle; 2nd pair, femur dark brown, with a yellow ring near tip; patella dark brown; tibia and metatarsus light yellow, with a broad brown band at the end, and a narrow brown ring near the middle; tarsus light yellow, the distal end dark brown; 3rd and 4th pairs of legs, the femur yellowish, with the distal end dark infuscated and a dark ring close behind; tibia and metatarsus as femur, and tarsus light yellow, with the tip darkened. Abdomen grayish, with four white dots, a short basal longitudinal middle line and the sides darkened.

Cephalothorax nearly as broad as long, flattened; both eye-rows recurved, the four M. E. form a trapeze which is higher than broad posteriorly; mandibles long, robust, parallel, and vertical, claw weak; maxillæ broad at tips, narrow at base, truncate in front; labium narrower at base than in middle, pointed at tip; sternum long and narrow, covered with white scaly hairs; abdomen triangular; i. e., elevated at the first third by two hunches, drawn out at blunt tubercles, which give the dorsal surface a geniculated appearance.

Three specimens from Guaymas.

#### 90. *Uloborus albineus* Marx ms.

PLATE XV, FIG. 18.

Female, long 4.2 mm.

Cephax. long 1.5, broad in middle 1.3; broad in front .6.

Abdomen 3.5, thick at the hunches 3.

Femur I 2, pat. and tibia 2. metat. 2. tarsus 1.

II 1.4 1.4 1. .5.

III 1. 1. .6 .5.

IV 1.6 2. 1.2 1.

Cephalothorax pale brownish yellow, pars cephalica covered with reddish brown hairs, which run over the whole dorsal surface, with the exception of a white margin at the sides; two black lines obliquely running from the base over the post-thorax, inclosing a pale yellowish triangular spot; mandibles and maxillæ brownish yellow, the latter with the inner margin white; labium at base yellow, at tip white; sternum brownish yellow, with black, long, stiff hairs. Legs pale yellowish, with pale brownish rings; only the distal half of metatarsus I is deep black. Abdomen white, with a long irregular blackish spot on the middle line behind the two hunches, hardly reaching to the apex.

Cephalothorax nearly as broad as long; both eye-rows recurved, the anterior M. E. by their diameter separated from each other, and larger than the S. E.; the four M. E. form a trapeze, broader than long, narrower in front; the anterior S. E. more separated from the anterior M. E. than they are themselves; mandibles, in front highly arched, parallel, vertical; maxillæ narrow

at base and broader in front, where they are truncate; labium longer than half the length of maxillæ, pointed very sharp at the tip. Abdomen very much geniculate on the dorsal surface by the two hunches and tubercles, nearly triangular; spinnerets long.

Two specimens from Hermosillo.

### THERIDIIDÆ.

91. *Theridium tepidariorum* Koch.—Two specimens from Hermosillo, and one from Cape Region. Appears to be more uncommon in the tropics than in the temperate regions.

92. *Theridium fordum* Keys.—Various specimens; Mt. Orizaba, Sierra San Lazaro, and Tepic. Also known to me from Texas. Closely related to the preceding species, but easily distinguished by its dotted legs.

93. *Theridium studiosum* Hentz.—Two examples from Tepic.

94. *Theridium spirale* Em.—Two from Tepic.

95. *Theridium frondeum* Hentz.—One young specimen from Tepic.

96. *Theridium rufipes* Lucas.

*Theridium albonotatum* Tacz., Horæ Soc. Entom., Ross., T. X., p. 1.

Two specimens; Tepic.

97. *Theridium rupicola* Em.—Two from Cape Region.

98. *Theridium confraternus*, sp. nov.

#### PLATE XIV, FIG. 11.

Very similar to *T. unimaculatum* Em., but no black spot on the cephalothorax. The legs are infuscated beyond the femora, and the femora have

a blackish stripe in front and behind. The legs are not as stout as in *T. unimaculatum*, the anterior femora being very much more slender. Length 1.8 mm.

One example from Tepic, Oct.

99. *Theridium elevatum* Bks.—One specimen from Tepic. Known from central Texas.

100. *Theridula triangularis* Keys.—Four from Tepic, Oct.

101. *Argyrodes americanus* Tacz.

*Argyrodes larvatus* KEYS, Die Spinn. Amer., Therid., p. 197.

Two examples from Tepic, Nov.

102. *Euryopsis funebre* Hentz.—One from Sierra San Nicolas.

103. *Spintharus flavidus* Hentz.—A young specimen from Baja California, without further locality given.

104. *Lathrodictes mactans* Koch.—Several from San Miguel de Horcasitas, San José del Cabo, Tepic, Minititlan, and Orizaba.

105. *Chryso splendida*, sp. nov.

PLATE XIV, FIG. 13.

Length 7.2 mm., femur I 10 mm. long. Cephalothorax whitish, blackish on the margin. Legs pale yellowish, base of femora with elongate black spots, black bands at middle and near tip of femora and tibiae (except tibia III which has a band at base and tip), and on tip of patellae and metatarsi; tips of palpi reddish; mouth-parts pale; sternum black, abdomen greenish gray, with a row of elongate clear yellow spots on each side, and some lower down near the spinnerets, a black tip to the projection, black spots near spinnerets, and a large black spot at base of venter. Cephalothorax low, moderately slender; eyes about equal in size; M. E. form a square; the P. M. E. not quite their diameter apart; mandibles quite stout, vertical; sternum longer than broad, sides rounded. Legs long and slender, femur I longer than body; metatarsus longer than tibia, clothed with long pale hairs, which at tips

of joints are denser, stouter, and black. Abdomen somewhat triangular, in side view, elevated and pointed behind, hardly compressed; region of epigynum swollen.

Two females; Tepic, Oct.

106. *Teutana grossa* Koch.—One specimen; San Miguel de Horcasitas. Determined by Dr. Marx.

107. *Teutana zonata* Keys.—One from Minititlan.

108. *Lithyphantes pulcher* Keys.

PLATE XIV, FIGS. 7 AND 8.

Not uncommon; San José del Cabo, Sierra San Lazaro, Sept., Sierra San Nicolas, Tepic, Oct. It varies quite a little in amount of coloration.

109. *Lithyphantes parvula* Marx ms.

PLATE XIV, FIG. 1.

Length ♀ 3.8 mm. Cephalothorax, the mouth-parts, and the sternum dark yellowish testaceous; eye-area somewhat infuscated. Legs of the same color, with the distal ends of the joints infuscated. Abdomen yellowish white, with six dark gray spots in two longitudinal rows over the dorsum, a similar colored transverse spot in front of these rows near the base. At the somewhat darker underside, the area between the fold and the spinnerets covered by a whitish, indistinct spot.

Cephalothorax nearly as broad as long, anteriorly less than one-half as broad as in the middle; posterior eye-row slightly recurved; M. E. closer together; anterior row recurved; four M. E. form an oblong which is higher than broad, and broader in front. Mandibles vertical, parallel; maxillæ inclined over the labium, which is about as long as broad, and pointed at the tip. Abdomen reaching high over the cephalothorax, broad, oval; legs 4, 1, 2, 3.

*Male*, slightly smaller; cephalothorax pale yellow testaceous; mouth-parts more brownish yellow, and the sternum yellowish brown, bordered with a brown line; the eye-area somewhat infuscated. Legs pale yellow, but also slightly infuscated at the distal ends of the joints. Abdomen whitish with four pair of dark brownish spots in two longitudinal rows, the first and second pair connected by a narrow purplish transverse line; the underside purplish brown with a spot in the center.

Cephalothorax one-fourth longer than broad, anteriorly one-third as broad as in the middle; posterior eye-row straight; M. E. slightly closer together;

anterior row recurved; four M. E. form an oblong which is higher than broad, and wider in front; mouth-parts as in the female; abdomen narrow oval.

Three specimens; San José del Cabo.

**110. *Lithyphantes punctulata* Marx ms.**

PLATE XIV, FIG. 4.

Cephalothorax 2 mm. long; abdomen 3 mm. long; leg I 7.6 mm. Cephalothorax and mouth-parts reddish brown, the maxillæ and labium with white tips; abdomen black, covered with dense hairs, with a narrow white line around the base, and with five pairs of white spots in two lines over the dorsum, outside of these lines three short transverse spots, the largest between the second and third dorsal spots; underside brownish, with two white spots in the center, one behind the fold, the other before the spinnerets; the sides with three pairs of white dots. Legs reddish brown, anterior femora and tips of tibiæ usually darker.

Cephalothorax as long as tibia I, slightly longer than broad, pars cephalica nearly half as wide as cephalothorax in the middle. Mandibles parallel, vertical; maxillæ inclined over the labium, truncate at tips; labium broader than long, rounded at tip. Posterior eye-row slightly procurved, eyes equidistant; anterior eye-row recurved, four M. E. form a quadrangle longer than broad; abdomen oval.

Four examples from Las Palmas.

**111. *Lithyphantes venusta* Marx ms.**

PLATE XIV, FIG. 2.

Ceph. 2 mm. long; abdomen 3 mm. long. Cephalothorax yellowish testaceous, eye-area somewhat infuscated; mandible, maxillæ, and labium of the same color, the two latter with white margins at their tips; sternum brownish yellow. Abdomen mottled with purple and brownish spots, with a broad, white transverse band over the base, and a white, longitudinal, narrow, middle band (from the middle to the apex), with serrated margins over the posterior half, and on each side a white spot about at the middle region from the lateral sides to the dorsal surface, and which continues to the brownish underside, an indistinct white spot between the fold and the spinnerets, legs yellowish testaceous.

Cephalothorax one-fourth longer than broad, as long as femur I. Posterior eye-row slightly recurved, equidistant; anterior much recurved; four M. E. form an oblong which is somewhat broader in front. Abdomen oval; with flattened dorsum. Legs 1, 4, 2, 3.

One specimen from San Francisco.

[Perhaps a variety of *L. pulcher* N. B.]

**112. *Lithyphantes transversus*, sp. nov.**

PLATE XIV, FIG. 5.

Length 4 mm. Cephalothorax, mouth-parts, sternum, and legs reddish, the latter slightly darker on the femora, one specimen is more suffused with fuscous; abdomen fuscous, above a broad basal transverse band, a middle chevron behind two pairs of small spots, and an apical band, silvery; venter with some basal spots, and two interrupted bands before the spinnerets, silvery. Cephalothorax moderately narrow, plainly longer than femur I; posterior row of eyes straight; P. M. E. less than diameter apart; M. E. form a quadrangle longer than broad. Legs short. Abdomen nearly truncate at base, nearly once and a half as long as broad, broadly rounded behind, slightly depressed and quite thickly clothed with black hair. The femora plainly shorter than in *L. pulcher*.

Two specimens; Sierra Laguna, El Taste.

**113. *Lithyphantes medialis*, sp. nov.**

PLATE XIV, FIG. 3.

Length 4-4.5 mm. Cephalothorax, legs, mouth-parts, and sternum wholly reddish yellow; abdomen fuscous or black, with a narrow basal curved band, a median row of four spots, the basal the largest, a lateral row of three spots and an apical band, silvery; venter paler than dorsum; a spot behind the epigynum, one in front of the spinnerets, and two each side, silvery. Cephalothorax moderately narrow, depressed; posterior eye-row nearly straight, P. M. E. almost their diameter apart; M. E. form a quadrangle higher than broad. Legs quite long; femur I much longer than the cephalothorax. Abdomen less than once and a half as long as broad, broadly rounded at base, more pointed behind, quite convex above, not very hairy.

Several specimens from San José del Cabo, and Sierra San Lazaro, Sept.

**114. *Lithyphantes autumnalis*, sp. nov.**

PLATE XIV, FIG. 6.

Length 3.9 mm. Cephalothorax dark reddish brown; legs more yellowish, with fuscous bands at ends of femora, patellæ, tibiæ, and metatarsi; sternum fuscous; abdomen fuscous, above a narrow curved basal band, two small spots, and four or five other bands behind, connected on sides and sometimes in the middle, forming a median stripe, all silvery; venter fuscous, with a spot behind the epigynum and two elongate spots each side near the spinnerets. Cephalothorax quite broad, more so than in allied forms, depressed; posterior eye-row barely recurved; P. M. E. less than their diameter apart. Legs

moderate; femur I about as long as the cephalothorax. Abdomen one and one fourth times as long as broad, broadly rounded in front and behind, quite high, quite thickly clothed with not very prominent hair. Epigynum not distinct.

Two specimens; Tepic, Oct.

**115. *Ceratinopsis rosea*, sp. nov.**

PLATE XIV, FIG. 15.

Length 1.5 mm. Cephalothorax and mandibles reddish; eyes on black spots; sternum a little darker; legs and palpi yellowish; abdomen dirty white, showing behind some paler narrow chevrons, grayish on venter. Cephalothorax gradually rising to eye-region; head not broadened; A. M. E. smaller than the other eyes, at least their diameter apart; posterior row of eyes straight, more than their diameter apart, about as far from S. E., the latter not raised on tubercles as in some species; mandibles quite large, two transverse ridges on the inner side of their front; sternum as broad as long, truncate between the hind coxæ, sides rounded. Legs short; femur I shorter than cephalothorax, moderately hairy, but without spines. Abdomen ovate, quite hairy; palpus black, has a strong hook on the tibia, which has a tooth above.

One male from San Francisquito, Sierra Laguna.

**116. *Grammonota gentilis*, sp. nov.**

PLATE XIV, FIG. 24.

Length ♀ 3.8 mm. Cephalothorax and mandibles light red-brown; sternum paler; legs dirty yellowish; abdomen pale grayish, with a black central stripe, and an incomplete lateral stripe, these are connected behind; venter with two indistinct dark lines. Cephalothorax quite broad, but slightly higher in the eye-region; A. M. E. small, close together; posterior row slightly procurved; P. M. E. about their diameter apart, farther from the S. E.; mandibles stout, with a row of large teeth each side of the fang. Legs short, quite stout; femur I much shorter than the cephalothorax, a spine above on middle of tibiæ and on tip of patellæ; all clothed with stiff bristles; sternum about as broad as long, pointed between hind coxæ, undulate on sides. Abdomen more than once and a half as long as broad, rounded in front, pointed behind.

One female; El Taste.

**117. *Grammonota* (?) *nigriceps*, sp. nov.**

PLATE XIV, FIG. 16.

Length 2.4 mm. Cephalothorax and legs pale yellowish; eye-region blackish; mandibles brownish; sternum yellowish; abdomen uniform gray.



The cephalothorax is quite slender, low, and considerably narrowed in front; eyes large and close together; posterior eye-row procurved; P. M. E. much less than their diameter apart, and barely further from the S. E.; A. M. E. smaller, nearly touching, quadrangle of M. E. higher than broad. Legs quite slender; femur I a little shorter than the cephalothorax, clothed with stiff bristles, one spine above on tibiae and one on tip of patellae; sternum a trifle longer than broad, sides rounded, tip barely produced between the hind coxae. Abdomen once and a half longer than broad, base rounded, apex pointed.

One female; Tepic, Nov. Possibly not this genus.

118. *Acartauchenius insanus*, sp. nov.

PLATE XIV, FIG. 12.

Length ♀ 3 mm., ♂ 2.4 mm. Cephalothorax, legs, and sternum pale yellowish, former and latter margined with blackish; abdomen whitish, with black median stripe, connected behind to a broader lateral one; a narrow line on each side of the venter, and blackish around the spinnerets. Cephalothorax considerably narrowed in front, highest at dorsal groove, higher in ♂ than ♀, sloping to the swollen clypeus; posterior eye-row strongly procurved; anterior row slightly recurved; A. M. E. smaller than other eyes, and touching; S. E. touching; P. M. E. a little more than their diameter apart; behind the P. M. E. in the ♂ there is a patch of stiff bristles; sternum barely longer than broad, sides rounded, pointed between the hind coxae. Abdomen more than once and a half as long as broad, moderately convex above and pointed behind. Legs short; femur I shorter than the cephalothorax; under tibiae I and II two rows of spines, one above on all tibiae and patellae; these are very long in the ♀ but short in the ♂.

Several specimens; San Miguel de Horcasitas.

119. *Tmeticus tridentatus*, *Em.*

*Erigone dentimandibula* KEYS (?), Die Spinn. Amer., Therid., p. 168.

One male from Tepic.

120. *Tmeticus incertus*, sp. nov.

PLATE XIV, FIG. 28.

Length ♀ 2.2 mm. Cephalothorax dull yellowish brown; legs paler yellowish; mandibles more reddish; sternum blackish; abdomen dark gray, darker on the venter, above with two large indistinct pale spots, and above the spinnerets a few narrow chevrons. Cephalothorax not very broad, not much

narrowed in front; posterior eye-row slightly recurved; P. M. E. less than their diameter apart, about as far from the S. E.; A. M. E. much smaller, slightly separated, quadrangle of M. E. higher than broad; no claw at tip of palpus. Legs moderate; femur I about as long as the cephalothorax, clothed with stiff bristles, and above on tibiae I, II, and III, two spines, only one seen on tibia IV; metatarsus I shorter than tibia I. Lower anterior border of mandibles with three or four small teeth; sternum slightly longer than broad, narrowly truncate between the hind coxae, sides rounded. Abdomen once and one-fourth longer than broad, base rounded, apex pointed, moderately convex above. Epigynum has two horny divaricate processes.

One female; Tepic, Nov.

**121. *Tmeticus denticulatus*, sp. nov.**

PLATE XIV, FIG. 29.

Length ♀ 2.5 mm. Cephalothorax yellowish brown, blackish on the seam; eyes on black spots; the mandibles more reddish; legs and palpi pale yellowish; sternum blackish; abdomen black, a few pale narrow chevrons above the spinnerets. Cephalothorax nearly once and a half as long as broad, not much narrowed in front; posterior eye-row about straight; P. M. E. their diameter apart, and about as far from the S. E.; A. M. E. a little smaller than other eyes, less than their diameter apart; quadrangle of M. E. as high as broad; no claw to tip of palpus; anterior lower border of mandibles with five quite prominent teeth; sternum a little longer than broad, truncate and deflexed between the hind coxae, sides rounded. Legs not very long; femur I shorter than the cephalothorax; metatarsus I barely shorter than tibia I; all with bristles; a spine on all patellae, two on tibiae I, II, and III, only one seen on tibia IV above. Abdomen oval, once and one-fourth longer than broad, higher than usual, almost subglobose.

Two examples; Tepic, Nov.

**122. *Pocobletus mexicanus*, sp. nov.**

PLATE XIV, FIG. 18.

Length ♀ 2.8 mm. Cephalothorax and legs pale yellow brown, a black seam on former; mandibles brighter than cephalothorax; sternum more blackish; abdomen dark grayish or blackish, darkest on venter, no pale marks, except a few narrow chevrons just above the spinnerets. Cephalothorax broad, much narrowed in front; posterior eye-row about straight; P. M. E. nearly their diameter apart, scarcely so far from the S. E.; A. M. E. much smaller, and half their diameter apart; quadrangle of M. E. about as broad behind as long; mandibles moderate, with two or three small teeth on lower

anterior margin. Legs quite large and long, quite thickly clothed with stiff bristles; metatarsus I shorter than tibia I; femur I plainly longer than the cephalothorax; sternum barely longer than broad; sides undulate; truncate and deflexed between hind coxæ; a large and prominent claw to tip of palpus. Abdomen quite large and high, somewhat globose, clothed with stiff bristles.

Two females; Tepic, Nov., and Agua Caliente.

**123. *Linyphia phrygiana* Koch.**—Three examples from San José del Cabo.

**124. *Linyphia communis* Hentz.**—Several specimens from Hermosillo.

**125. *Linyphia litigiosa* Keys.**—One from San José del Cabo.

**126. *Linyphia eiseni* Marx ms.**

PLATE XIV, FIG. 10.

Length ceph. 2 mm.; abdomen 3 mm. Cephalothorax olive-yellow, with a broad brownish marginal band around the thoracic part, pars cephalica with a dark brownish line on its sides, and over the eye-area infuscated; mandibles, maxillæ, labium, and sternum olive yellowish brown; legs of the same color, with dark rings at the distal ends and around the middle of the joints. Abdomen pale olive-yellow, with a blackish brown lance-shaped spot from the base to the end of the first third, five or more transverse bands from each side to near the venter, where they do not quite touch each other, the first reaching the lance-shaped spot at its broadest part, the sides with irregular blackish spots; underside blackish with two lighter colored lines.

Cephalothorax one-quarter longer than broad; mandibles long, parallel and vertical; maxillæ slightly inclined over the labium, which is about as broad as it is long and truncate at tip; posterior eye-row straight, eyes equidistant, anterior row recurved; the M. E. smaller, the four M. E. form a quadrangle which is narrower in front and higher than broad. Abdomen about twice as long as broad. Legs long, with some spines; the upper spinnerets two-jointed.

One female; Magdalena Island.

**127. *Linyphia dorsalis*, sp. nov.**

PLATE XIV, FIG. 9.

Length ♂ 2.5 mm. Cephalothorax, legs, mandibles, and sternum all pale yellow, the former with a black dorsal stripe; abdomen gray on the sides,

white above, and with a broad median reddish stripe. Legs and abdomen clothed with long black hairs. Cephalothorax low, quite slender; P. M. E. more than their diameter apart, a little closer to S. E.; A. M. E. as large as P. S. E., and about their diameter apart; mandibles quite long, vertical. Legs quite short; femur I much stouter than other pairs, and a little longer than cephalothorax, all with many slender spines; sternum longer than broad, pointed behind. Abdomen a little less than twice as long as wide, base truncate, apex broadly rounded. The palpus has a slender, nearly straight tube extending from near base to tip, a quite strong curved hook at base; tibia slightly prolonged on the inner side.

One male; no locality.

**128. *Floronia adstricta* Keys.?**—One female, probably this species, which was described from a male from Utah.

**129. *Bathyphantes transversus*, sp. nov.**

PLATE XIV, FIG. 14.

Length 2 mm. Cephalothorax yellow-brown, darker on margin; eyes on black spots; legs yellowish, an indistinct dark spot near base of femur, and indistinct dark bands near middle and tip of tibia; sternum yellowish. Abdomen whitish, with four or five transverse black bands, and the apex black; venter darker, with a black stripe each side and over middle of base. Cephalothorax broad, depressed; head broad; posterior eye-row procurved; P. M. E. less than their diameter apart; sternum as broad as long, blunt-pointed between hind coxæ, sides rounded. Legs slender; femur I as long as the cephalothorax, hairy, and with a few scattered spines. Abdomen about twice as long as broad, truncate at base, pointed behind. Palpus large, the tarsus is swollen above, the tube is coiled once around on top of the bulb, the hook is not very prominent.

One male; La Chuparosa.

**130. *Bathyphantes formica* Em.**—One female; El Taste.

**131. *Bathyphantes tragica* Marx ms.**

PLATE XIV, FIG. 17.

Length ♀ 2.3 mm. Cephalothorax light olive brown, with a darker, indistinct and often interrupted marginal band, pars cephalica small, with a dark brown V-shaped spot at its posterior angle, from the eyes of the posterior row dark lines extend to this V-shaped spot; mandibles olive brown; maxillæ dark olive brown, with the inner half white; labium dark olive brown, with a white line at tip; sternum dark olive brown. Abdomen gray, with a blackish

longitudinal stripe over the anterior region, followed by four blackish, triangular spots, the sides speckled with blackish spots; the underside pale, with some darker lines. Legs olive brown, with infuscated distal regions to the joints. Cephalothorax a little longer than broad, anteriorly one-half as wide as in the middle; posterior eye-row straight; eyes equidistant; anterior row recurved; A. M. E. closer together; four M. E. form a quadrangle higher than broad, and narrower in front; abdomen pyriform, tapering toward the apex. Legs long and slender; mandibles long, straight, parallel, and vertical; maxillæ separated, not longer than broad, more than twice as long as the labium, which is about twice as broad as long. Male similar to the female, but the cephalothorax and legs paler, yellowish, and the markings on the abdomen less distinct.

Two specimens; Guaymas, May, and San Miguel de Horcasitas.

### TETRAGNATHIDÆ.

132. *Tetragnatha mandibulata* Walck.—San José del Cabo and Tepic, Nov. The ♀ has a tooth on the fang at base.

133. *Tetragnatha grillator* Hentz.—Sierra Laguna and San José del Cabo. Those from the latter place are smaller but appear to be the same species. The eyes are farther apart than in our northern specimens, but like those from Texas.

134. *Tetragnatha peninsulana*, sp. nov.

#### PLATE XV, FIG. 12.

Length ♂ 7.5 to 9 mm.; femur I 8.1 mm. long. Mandibles as long as the cephalothorax, more porrect than usual, very pale, the large tooth above is placed almost at extreme tip, and the one on inner margin is moved forward; tibia of palpus once and one-third longer than patella. Length ♀ 10 mm., femur I 7.2 mm.; abdomen 2 mm. wide. Mandibles nearly four-fifths as long as cephalothorax, no tooth on outside of fang, which is wavy. Abdomen cylindrical, scarcely enlarged at base; cephalothorax pale yellowish, sometimes with blackish marks; abdomen with a folium above, below there is a black stripe margined with silvery. The S. E. are farther apart than in the other species, but hardly as far as the M. E.; they are often connected by a blackish line.

Two males and several females; San José del Cabo.

**135. *Tetragnatha fraterna*, sp. nov.**

PLATE XV, FIG. 11.

Length ♂ 9.5 mm. long; femur I 8.5 mm. long. Mandibles about as long as the cephalothorax, yellowish, a small tooth between the large one above and the margin, fang long and wavy; tibia of palpus a little longer than patella. Length ♀ 10 mm.; femur I 8 mm. long; abdomen 2 mm. wide. Cephalothorax yellowish, with blackish marks; abdomen with a folium above, and a black median stripe below. Mandibles less than two-thirds as long as cephalothorax; fang short, evenly curved, scarce a trace of a tooth on outside at base. Abdomen nearly cylindrical, rather larger at base. Eyes of posterior row at equal distances; A. S. E. very much smaller than P. S. E., which they touch. Two ♀ with a large abdomen at base are closely related, but are perhaps different.

One male and several females; San José del Cabo. It has shorter mandibles than *T. grallator*, a more slender body, and the ♀ fang not curved.

**136. *Tetragnatha convexa*, sp. nov.**

PLATE XV, FIG. 10.

Length ♂ 10 mm.; femur I 12 mm. Mandibles almost as long as the cephalothorax, yellowish, apical half convex on outer side, no tooth between large one above and the inner margin; tibia of palpus once and a half as long as patella. Length ♀ 13 mm.; femur I 11 mm. long. Cephalothorax yellowish, with some faint dark marks; abdomen with a distinct folium above, a narrow silvery stripe each side on venter; sternum dark. Mandibles three-fourths as long as cephalothorax, much more convex (seen from the side) than usual, a prominent tooth on outer side of fang at base, and a large black one over the base of fang. Abdomen 3.1 mm. broad, enlarged at base. The A. S. E. hardly smaller than the P. S. E.; the P. M. E. rather closer to each other than to the P. S. E.

Several specimens; San José del Cabo.

**137. *Tetragnatha intermedia*, sp. nov.**

PLATE XV, FIG. 14.

Length ♂ 8.5 mm.; femur I 8.5 mm. long. Mandibles four-fifths as long as the cephalothorax, yellowish, fang long, rather wavy; tibia of palpus short, but little longer than patella. Cephalothorax yellowish, marked with blackish; sternum yellowish; abdomen dark, cylindrical. Eyes of posterior row about equally distant; A. S. E. smaller than P. S. E.

It has much resemblance to a small *T. grallator*, but has shorter mandibles, and there is a tooth between the large one above and the inner margin (which is not seen in *T. grallator*).

Three males; Tepic, Nov., and a few young ones.

**138. *Tetragnatha atriceps*, sp. nov.**

PLATE XV, FIG. 13.

Length ♂ 7 mm.; femur I 6.5 mm. long. Mandibles three-fourths as long as the cephalothorax, dark red brown, almost black, stout, outer margin rather sinuous, large tooth above, another almost as large nearer to inner margin, the long one on inner margin more erect than in other species; fang short, evenly curved; tibia of palpus much longer than patella, which is very short, whole palpus short; P. M. E. rather far apart. Cephalothorax yellowish; sternum pale; abdomen gray-brown, dotted with silvery, slender, cylindrical; head infuscated.

One male; El Taste. Easily known by its dark mandibles and the two large teeth above.

**139. *Eugnatha pallida* Banks.**—Male and female from Tepic, Oct.

**140. *Eugnatha orizaba*, sp. nov.**

PLATE XV, FIG. 16.

Length ♂ 5 mm.; femur I 4.2 mm. Mandibles two-thirds the length of the cephalothorax, pale, large tooth above is stout and blunt at tip; tibia of palpus barely longer than patella, palpus very short. Length of ♀ 7.5 mm.; femur I 4.2 mm. long; abdomen 1.6 mm. wide. Cephalothorax yellowish; abdomen rather silvery above (discolored). Mandibles one-half as long as the cephalothorax, no tooth on outer side of fang, which is nearly evenly curved. Eyes of the posterior row at equal distances; S. E. equal in size, and full as far apart as the M. E.; abdomen cylindrical.

One pair from Mt. Orizaba.

**141. *Glenognatha minuta*, sp. nov.**

PLATE XV, FIG. 15.

Length ♂ 3 mm.; femur I 1.8 mm. long. Cephalothorax reddish, with a black stripe in the middle, and spots each side; eyes on black spots; man-

dibles reddish. Legs pale, tips of joints blackish above. Abdomen brownish with a median row of silvery spots, and three large ones each side, sometimes blackish around the spots; venter dark, with a row of three pale spots each side; sternum red-brown. The four M. E. form a square; the S. E. touching, some distance from the M. E.; four teeth above on mandible, the two middle ones the larger, two very large ones below; a very distinct furrow on venter, nearer to the spinnerets than to the lung-slits.

Two males; San José del Cabo. Differs from *G. emertoni* in smaller size and armature of the mandibles.

## EPEIRIDÆ.

### 142. *Gasteracantha cancriformis* Linn.

*Epeira cancer* HENTZ., Spiders of the U. S., p. 126.

Two specimens from San Quentin, two from Magdalena Island, and one from Orizaba.

### 143. *Gasteracantha hexacantha* Fabr.

*Gasteracantha velitaris* KOCH, Die Arach., IV, p. 33.

*Gasteracantha rufospinosa* MARX, Entom. Amer., Vol. II, p. 25.

Many specimens from Tepic, Sierra Laguna, and Guaymas.

### 144. *Acrosoma funebre* Marx ms.

*Female*.—Cephalothorax 2 mm. long; abdomen 5 mm. long. Cephalothorax glossy black, mandibles blackish brown; maxillæ black with the inner margin white; labium blackish at base with a white tip; sternum glossy black; first coxæ black, second and third pale yellow testaceous, fourth testaceous with a black spot at underside. Abdomen black with fifteen white spots on the dorsum, five pair on each side, two inside of these two rows, side by side before the center, one larger at the center, and two behind the center and before the posterior superior spines, which are spotted with white at the sides; underside black with seventeen white spots—eight on each side, and one in the posterior region between the inferior posterior spines. Legs and palpi yellow, with a blackish ring on the distal end of the joints.

Cephalothorax considerably longer than broad, with a round impression at the base of pars cephalica. The four M. E. form a square which is slightly



wider posteriorly; they stand on a common tubercle; the S. E. are also placed on the sides of a tubercle and are slightly separated from each other; mandibles robust and parallel; maxillæ and labium as usual; sternum small, shield-like, somewhat redrawn from the coxæ, with a prominent tubercle opposite the coxæ; abdomen subcylindrical with only two pairs of spines at the posterior extremity; legs, fourth pair longest.

A few specimens; Calmalli Mines, Sierra San Nicolas, and Mazatlan.

**145. *Acrosoma militaris* Fabr.?**—Two specimens from Margarita Island appear to belong to this species.

**146. *Acrosoma rugosa* Hentz.**—Many from Tepic and Orizaba. A large variety.

**147. *Acrosoma mitrata* Hentz.**—One specimen; Tepic. Larger and darker than usual.

**148. *Acrosoma 12-spinosum* Cambr.**—One specimen; Tepic.

**149. *Mahadeva verrucosa* Hentz.**—Several specimens from Tepic.

**150. *Plectana stellata* Hentz.**—Two specimens; Tepic.

**151. *Gea heptagon* Hentz.**—A few specimens from San José del Cabo.

**152. *Ordgarius obesus*, sp. nov.**

PLATE XV, FIG. 9.

Length of ♀ 15 mm.; breadth of abdomen 15 mm. Cephalothorax dull yellowish brown; legs paler, uniform; sternum brownish, a little yellowish in center; abdomen yellowish, with golden lines coming up on the sides, four indented dark spots, the anterior pair in a yellow region, base of abdomen mostly grayish and extending behind in the middle, more or less broken up with yellow. Cephalothorax elevated, pars cephalica spinulated, two prominent elevations behind, truncate at tip and terminated at each corner by a

more prominent spinule; M. E. on a slight elevation. Legs short; femora curved near tip. Abdomen not very high, extending over the basal part of the cephalothorax, plainly broader than long. The epigynum consists of a small transverse at the margin of the rima genitalis.

Two specimens from La Chuparosa. Distinguished from *O. bisaccatus* Em., by the processes on the cephalothorax being truncate at tip, and by its much larger size.

**153. *Ordgarius corpulentus*, sp. nov.**

PLATE XV, FIG. 8.

Length ♀ 13 mm.; abdomen, broad 10 mm., high 10 mm. Cephalothorax blackish in the front and elevated part, with the tubercles tipped with yellow, behind pale. Abdomen dark grayish, markings not distinct; venter yellowish; sternum and coxæ reddish; femora and tibiae of legs reddish, darkest on anterior pairs, tarsi and metatarsi yellowish. Legs clothed with long white hair. Eyes as usual; cephalothorax gradually elevated, at the ridge divided into four lobes, the median pair smaller and barely higher than the lateral, terminated with two large blunt tubercles; a number of scattered blunt tubercles in front, some as large as those on the ridge. Abdomen high, globose, with two widely separated, conical projections above.

One specimen; San José del Cabo, Sept. This species is related to *O. conigerus* Hentz., but is larger and has tubercles on the anterior sides as well as the pars cephalica, all tipped with yellow; the median elevation is barely higher than the sides, and not furcate; the legs have no bands; and the projection above on abdomen is taller, but not of greater diameter.

**154. *Epeira 11-tuberculata* Keys.**—One specimen; Tepic. Near to *E. spicata* Cambr.

**155. *Epeira perplexa*, sp. nov.**

PLATE XV, FIG. 1.

Length ♀ 11 mm.; abdomen, broad, 7.5 mm. Clothed with short stiff white hair. Cephalothorax dull yellowish; mandibles pale; legs yellowish, anterior femora reddish, a dark band on middle and tip of hind femora, and spots beneath at tips of the joints, more prominent on the hind pair, all tarsi

black tipped, black spots on coxæ, except first pair; sternum pale, with a dark brown median spot, widest in front; abdomen yellowish, grayish behind, sides lined with black, two black patches on the venter. Cephalothorax broad in front; pars cephalica with a transverse hump each side behind the eyes; eyes on elevations; P. M. E. closer together and larger than A. M. E. Legs rather short. Abdomen nearly circular in outline, depressed, with a circle of conical humps above, three near each anterior side, two on each, posterior side, the hindmost the larger, and between these a median row of three small humps above the spinnerets, hind margin of abdomen vertical; the epigynum shows a median tapering finger with a blunt tip. In what I take to be young specimens of this species, the abdomen is much narrower and higher at tip.

One adult female; Sierra San Nicolas; young from Cape Region. Related to *E. hoxæa* Cambr., but it is different, has a longer epigynum.

**156. *Epeira gemma* McCook.**—Several specimens from San Julio, San José del Cabo, and Ensenada.

**157. *Epeira singularis*, sp. nov.**

PLATE XV, FIG. 4.

Length ♀ 7.5 mm.; abdomen, broad 5.5 mm. Cephalothorax pale reddish brown; legs similar, yellow on base of femora, tibiæ, and most of metatarsus; sternum and coxæ yellowish; abdomen dark gray, not uniform, but no distinct markings, four deeply impressed dots, and behind three parallel dark lines extending to tip; venter with two large pale spots. Cephalothorax and legs clothed with fine white hair. Cephalothorax broad in front; P. M. E. barely larger, but a little farther apart than the A. M. E. Legs short; sternum a little longer than broad, triangular. Abdomen broad, nearly circular, moderately high, just above spinnerets transversely wrinkled, on each side near base is a large but very low hump. The epigynum has a finger more slender than *E. vulgaris* and less slender than *E. trivittata*.

One female; Pescadero.

**158. *Epeira balustina* McCook.**—One female; Tepic. A large species, with black femora.

**159. *Epeira bivariolata* Cambr.**—Determined by Dr. Marx. The epigynum is longer, and I feel doubtful. Like

*E. prompta* it varies in markings. Several from Tepic, Coral de Piedras, El Taste, Sierra Laguna, and Sierra San Nicolas.

**160. *Epeira conchlea* McCook.**

*Epeira clavispina* CAMBR., Biol. Cent. Amer., Arach. Aran., p. 37.

Larger than *E. prompta*, and with one or two cones at the tip of abdomen; the epigynum broader at base. La Chuparosa, Sierra Laguna, San José del Cabo, and Sierra San Nicolas, July.

**161. *Epeira prompta* Hentz.**

*Epeira parvula* KEYS, Besch. n. Orbitel., p. 131.

San José del Cabo, Coral de Piedras, and Tepic.

**162. *Epeira detrimentosa* Cambr.**

PLATE XV, FIG. 7.

Length 5 mm. Cephalothorax pale yellowish brown, clothed with white hair; legs similar, with dark rings at ends of femora and tibiae, sometimes a median ring on anterior femora and tibiae, and sometimes a brown stripe under these joints; sternum pale brown, with a central yellow line; abdomen grayish, with a broad blackish stripe on each anterior side, sometimes margined internally with a white line, mottled above with blackish, and traces of a folium behind; venter blackish, with two spots and a band behind epigynum yellow; the abdomen above is sometimes cream-white, showing four brown dots, in one specimen it is greenish. Cephalothorax a little longer than broad. M. E. equal, forming a quadrangle a little narrower behind than in front; P. M. E. their diameter apart; sternum a little longer than broad, sides rounded. Legs moderate; femora I a little shorter than cephalothorax, with quite long spines. Abdomen globose, a little broader than long. The epigynum has a striated finger, barely surpassing the circular cavity over which it rests.

Sierra San Nicolas and Mazatlan. As it also occurs in southern Texas the above description is given.

**163. *Epeira helveola* Cambr.**—Determined by Dr. Marx. One male; San José del Cabo.

164. *Epeira vertebrata* *McCook*.—Many from Tepic, Nov.; a few from San José del Cabo and Sierra San Nicolas.

165. *Epeira trivittata* *Keys*.—A few specimens; Orizaba, Guaymas, and Tepic.

166. *Epeira strix* *Hentz*.—Four specimens; Agua Caliente and Orizaba.

167. *Epeira vulgaris* *Hentz*.

*Epeira volucris* *Keys*, N. Spinn. a. Amer., VI, p. 528.

Adult ♀ from 8 to 10 mm. long. Sternum with a bright yellow stripe in the center; the yellow lunules on the venter are reduced to spots; the pale cross above is the principal mark seen; at the base is sometimes the beginning of a folium, also noticed at tip; on the sides the pale is limited by an irregular blackish stripe; all of the femora show more or less distinctly a ring on the middle as well as at tip. The finger of the epigynum, when elevated, gives the appearance figured by Keyserling. The M. E. are equal; the P. M. E. closer together than the A. M. E.

Three females from Orizaba. This species is different from *E. sclopetarius*, as Emerton suggests in his N. Eng. Epeiridæ.

168. *Epeira labyrinthica* *Hentz*.—A few specimens from each of the following localities: Tepic, El Taste, Cape Region, Orizaba, San Miguel de Horcasitas, Sierra San Nicolas.

169. *Epeira globosa* *Keys*.

*Epeira solersioides* *CAMBR.*, Biol. Cent. Amer., Arach. Aran., p. 25.

Several from Tepic and San José del Cabo.

170. *Epeira placida* *Hentz*.—Sierra San Lazaro, Sept., and El Taste.

171. *Epeira foliata* Hentz.—Male and female; Tepic.

172. *Epeira gibberosa* Hentz.—A few specimens; El Taste and San José del Cabo.

173. *Epeira zilloides*, sp. nov.

PLATE XV, FIG. 2.

Length ♀ 7.5 mm., ♂ 4 mm. Cephalothorax yellowish, blackish on pars cephalica and extending back to dorsal groove; mandibles brown; sternum brown, yellowish in middle; legs pale, all the joints (except hind femora) brownish, or with a brown ring at tip. Abdomen grayish, more yellow or white at base and with a blackish spot each side, but the folium not continued, a few dark spots and faint lines behind; venter with a broad dark region, containing a pale spot behind the epigynum; ♂ with the legs less distinctly marked. P. M. E. less than their diameter apart, smaller than the A. M. E., which are more than their diameter apart; mandibles rather prominent. Legs short and stout; abdomen elliptical, broadly rounded in front and behind. The epigynum shows a transverse elliptical brown area and two darker spots in front. The palpus is rather complicated; the tibia broad, with very long bristles; the tarsus short.

A few specimens from Tepic, Oct. Different from *E. gregalis* Cambr. Looks like *Zilla californica* Bks., but in that species the anterior femora are not darker at tips, there is a band on middle of hind tibia, the folium on abdomen is complete, and the ventral mark is narrower and without a pale spot.

174. *Epeira caudata*, sp. nov.

PLATE XV, FIG. 5.

Length ♀ 10 mm.; tibia I 3.5 mm; metatarsus I 3 mm. Wholly pale yellowish, except a dark stripe from the epigynum to spinnerets; abdomen sometimes greenish. Cephalothorax about once and a half as long as broad, clothed with pale hair; M. E. equal, forming a quadrangle nearly as long in front as high, and a little narrower behind; P. M. E. separated by more than their diameter; A. M. E. by twice their diameter; S. E. smaller than M. E. and considerably separated from them, and slightly from each other. Legs quite thickly clothed with white hairs and some scattered spines; sternum once and a half as long as broad, pointed behind. Abdomen not quite three times as long as broad, somewhat pointed in front, and continued behind in a cone, which is sharp pointed at its tip. Male 8 mm. long, similar to female, except anterior femora

rather stouter and the spines on tibia stronger; tarsus of palpal organ quite slender, the bulb very large, and a large hyaline projection on one side.

Two specimens; Tepic, Oct.

**175. *Vixia infumata* Hentz.**—One specimen with no locality, and one from Tepic.

**176. *Singa mæsta*, sp. nov.**

PLATE XV, FIG. 3.

Length 3 mm. Cephalothorax brownish on sides, pale yellowish in middle, thinly clothed with white hairs; legs pale yellowish, tibiae of anterior pairs with a black line in front, anterior femora darker at tip; posterior tibia darker at tip; sternum red-brown; venter black in middle, yellow on sides; a broad black stripe on each side of abdomen; white above, with two black stripes from base to tip in the form of a folium, more or less connected, especially near tip; an incomplete median black line. Cephalothorax not much narrowed in front; P. M. E. a little larger than A. M. E.; M. E. form a quadrangle higher than broad; sternum broadly triangular. Legs short, with a few spines and many stiff hairs. Abdomen about once and a half as long as broad, somewhat depressed, broadly rounded in front and behind. Anterior metatarsus shorter than tibia I, posterior metatarsus longer than tibia IV.

One female; Tepic.

**177. *Cyclosa conica* Pall.**

*Epeira caudata* HENTZ., Spiders of the U. S., p. 114.

Four specimens; Guaymas.

**178. *Cyclosa index* Cambr.**—Several from Calmalli Mines; also known to me from Los Angeles, Calif.

**179. *Cyrtophora fusiformis* Tacz.**

*Turckheimia diversa* CAMBR., Biol. Cent. Amer., Arach. Aran., p. 136.

Sierra San Nicolas, Mazatlan, Mt. Orizaba, and Tepic.

**180. *Argiope transversa* Em.**—Two from Orizaba; one from Sierra San Nicolas.

181. *Argiope argentata* Fabr.—A few from San José del Cabo and Tepic.

182. *Argiope personata* Cambr.—A large number from Tepic, Nov., and two specimens from San Miguel de Horcasitas.

183. *Nephila clavipes* Fabr.—Many from Tepic, Nov. This is by most American authors called *N. plumipes*, which is, however, a South American species not known in the north.

184. *Nephila hasselti* Dolesch.—One entire specimen and one abdomen, from Baja California, appear to belong, without doubt, to this East Asian species.

185. *Argyropeira argyra* Walck.—Several from Sierra Laguna and Minititlan; many from Tepic.

186. *Argyropeira argentea* Keys.—Many specimens from Tepic.

187. *Argyropeira maura* Hentz.?—Two specimens from Tepic, Oct., are quite possibly this species, but somewhat differently marked.

188. *Larinia directa* Hentz.—One specimen from Tepic.

189. *Larinia bellona*, sp. nov.

PLATE XV, FIG. 6.

Length ♀ 7 mm.; tibia I 3.4 mm.; metatarsus I 3.8 mm. Cephalothorax, legs, and mandibles pale yellowish, a median reddish stripe from M. E. to dorsal groove, margin sometimes blackish; sternum pale yellowish, brown on sides; legs usually dotted with reddish at base of spines; abdomen grayish; with several more or less distinct wavy lines above, usually outlining a pale central stripe; venter with a brown stripe each side, uniting in front of the spinnerets. The cephalothorax is slender, narrowed in front, nearly twice as long as wide; quadrangle of M. E. a little more narrow than in *L. directa*; sternum less than twice as long as wide. Abdomen twice as long as wide, pointed in front, more rounded behind. The male is 4 mm. long, colored as in female; the legs more slender.



Several specimens from Sierra San Nicolas, Guaymas, and Tepic, Nov. Readily separated from *L. directa* by its shorter abdomen. Some from Tepic have the front legs and abdomen more reddish than the others.

190. *Azilia mexicana*, sp. nov.

PLATE XV, FIG. 19.

Length of  $\delta$  7 mm.; leg I 26 mm. Cephalothorax pale, with four forked blackish streaks above; mandibles yellow-brown; sternum dark, with a pale central spot; legs pale, with brown rings at the end and middle of the joints. Abdomen dark grayish, with a paler stripe in the center, and a darker stripe each side broken somewhat into spots; venter gray, rather pale in middle. Eye-region sloping, clypeus extremely narrow, both rows of eyes recurved, the M. E. rather larger, and the P. M. E. closer to S. E. than to each other; sternum plainly longer than broad, triangular. Legs long, especially the first pair, with a few long spines; fourth pair plainly shorter than the second. The abdomen rather narrow, high, and convex, twice as long as broad, pointed at tip. The  $\delta$  palpus has a quite long blunt projection on the tibia; the bulb is rather simple, with a stout, slightly curved style toward the tip.

One adult male; three immature from Tepic, Nov. Quite distinct from *A. guatemalense* Cambr.

191. *Chrysometa alboguttata* Cambr.?

*Meta alboguttata* CAMBR., Biol. Cent. Amer., Arach. Aran., p. 2.

One immature specimen from Tepic is probably this species; it hardly agrees with *Chrysometa*, yet is much nearer to this genus than any other known to me.

THOMISIDÆ.

192. *Xysticus 4-lineatus* Keys. — Two specimens; La Chuparosa and Sierra Laguna.

193. *Xysticus fissilis*, sp. nov.

PLATE XVI, FIG. 5.

Length  $\delta$  4.4 mm.; ceph. 2.3 mm. long, broad 2.4 mm.; femur I 2.7 mm. Cephalothorax black on the sides, a yellowish stripe in the middle, whose anterior part is wholly occupied by a dark red-brown spot, extending back along

the median line to the point where the abdomen overlaps the cephalothorax, a narrow white band connects the A. S. E. and passes between the four M. E.; mandibles dark red-brown, a small white line on their outer tip; sternum dark brown, with some pale spots; coxæ pale, with a median line and some spots brown; femora and patellæ of anterior pairs black, usually showing a narrow white line beneath and spots above at tips, rest of these legs pale yellowish, with the tibiæ infuscated at base; posterior legs mottled, the femora with a white line below, the tibiæ and patellæ with one above. Abdomen white above, with an oblique brown mark each side at base, behind are three pairs of transverse spots more or less connected, various small dark dots, sometimes some of them indicate a narrow basal spear-mark; venter mottled, darkest at base. A. M. E. equal to P. M. E., a little nearer to A. S. E. than to each other. Four pairs of spines under tibiæ and metatarsi I and II. The tibia of the  $\delta$  palpus has a large projection on the inner side, the tarsus is broad, the style extends around, and on the outer side at base is a projection outward for the tip of the style, in the middle of the bulb are two teeth curving toward each other, the upper the larger. A  $\varnothing$  (scarcely mature) has the side-stripes of the cephalothorax divided behind, and a median dark line. The legs are mottled, brown bands before middle and apex of tibiæ. The abdomen pale, with small spots in the position of those of the  $\delta$ , and various dark dots; the sternum spotted; the legs shorter than in  $\delta$ .

Four males and one female; Tepic, Oct. and Nov.

#### 194. *Xysticus apertus*, sp. nov.

PLATE XVI, FIG. 7.

Length 7 mm.; ceph. 3 mm. long, broad 3 mm.; femur I 2.8 mm. Cephalothorax brown on the sides, ending in two darker brown spots, a black median point, in front of which it is brownish, two darker median lines, a white band connecting the S. E.; mandibles mottled with brown at base, pale at tip; sternum dotted with brown; a black line on coxæ, and a spot on trochanters; anterior legs very thickly mottled with brownish, posteriorly paler on the femora, metatarsi and tarsi paler, a white line above on the patellæ and tibiæ; hind legs less spotted, a large spot on the middle of femora and a still larger one at the tip, and on the base and tip of patellæ and tibiæ. The abdomen has a broad dentate whitish stripe in the middle, and pale brownish ones on the sides, formed of the usual spots connected; sides and venter dotted with brown. A. M. E. as large as P. M. E., and fully as far apart, plainly nearer to the A. S. E. than to each other. Four pairs of spines under anterior tibiæ and metatarsi; sternum rather narrow, much longer than broad. Abdomen very short, broader than long.

One female and one young male; Cape Region.

#### 195. *Xysticus discursans* Keys.

*Xysticus bimaculatus* Em., Can. Spid., p. 416.

One female, 5.2 mm. long, from Agua Caliente. It is

quite readily known by having only one large spot behind on each side, not divided as usual.

In my Colorado list I accidentally put *X. bimaculatus* under *X. montanensis*, whereas it goes here; and vice versa *X. pulverulentus* is a synonym of *X. montanensis*, instead of *X. discursans*.

**196. *Xysticus curtus*, sp. nov.**

PLATE XVI, FIG. 8.

Length 5.5 mm.; ceph. 2.3 mm. long, broad 2.3 mm.; femur I 2.1 mm. Cephalothorax whitish above, brown on sides, ending behind in two spots scarcely darker, a median pointed spot, in front a rather darker area, clypeus whitish; mandibles pale, with brown at base; femora pale beneath, mottled above; tibiae and patellae with two brown stripes above, between them a white line; hind pairs slightly mottled; sternum grayish, with brown dots. Abdomen gray, with indistinct transverse brown spots on the posterior part, and two short faint stripes in front. A. M. E. equal to P. M. E., and fully as far apart, plainly nearer to the A. S. E. than to each other; four pairs of spines under anterior tibiae and metatarsi; sternum rather broad. Abdomen small, broadest just behind the middle, broadly rounded behind.

One female; Cape Region.

**197. *Xysticus orizaba*, sp. nov.**

PLATE XVI, FIG. 6.

Length 9 mm.; ceph. 3.8 mm. long, broad 3.4 mm.; femur I 3.4 mm. Cephalothorax mostly brownish in front, pale behind, each brown side terminated behind by two dark brown spots, the middle area terminated behind by a pointed spot; a darker band connects the S. E., in front of which it is white; mandibles mottled, paler at tips. Legs mottled, but the femora mostly pale below, a white line above on patellae and tibiae; sternum thickly dotted with brown; long mark on coxae, and a spot on the trochanters dark brown. Abdomen with a large brown spot above, margined with pale; sides and venter pale, dotted with brown. A. M. E. fully as large as P. M. E., plainly nearer to the A. S. E. than to each other, but hardly so far apart as the P. M. E.; four pairs of spines under anterior tibiae and metatarsi; sternum much longer than broad. Abdomen large, rather depressed, broadest behind the middle, broadly rounded behind. Male 5 mm. long; ceph. 2.1 mm. long; femur I 2.5 mm. long. In general similar to the female, but the femora spotted below, and the anterior tibiae and metatarsi darker than the rest of leg. The abdomen of a rich brown color above, with transverse irregular spots, and margined with white.

Several specimens from Orizaba and one from Agua Caliente.

198. *Synæma æquinoctialis* Tacz.?—One specimen, immature, from Tepic, probably this species.

199. *Synæma* sp.?—Three specimens, all young, from Tepic, probably new, but not large enough for description.

200. *Misumena gracilis* Keys.—Several specimens from Tepic, Nov.

201. *Misumena dubia* Keys.—Several specimens from Tepic, Oct., Nov.

202. *Misumena fidelis*, sp. nov.

PLATE XVI, FIG. 2.

Length 7 mm.; ceph. 2.7 mm., broad 2.7 mm.; femur I 3.8 mm. Cephalothorax, legs, and mandibles yellowish, a double white spot above on the former, a white point at the tips of the latter, a white band connects the S. E.; sternum pale; abdomen yellowish, above with two converging rows of distinct black spots, ill defined, starting at middle, sometimes a median spot in front of them, and one on each posterior side. Eyes of anterior row at about equal distances; M. E. form a square. Legs of moderate length; four pairs of spines under tibiae I and II; seven and eight under metatarsi I and II. Abdomen broadest in the middle, pointed behind, rather high.

Several specimens from El Taste, La Chuparosa, and San José del Cabo.

203. *Misumena rosea* Keys.—Several examples from San José del Cabo.

204. *Misumena mexicana* Keys.?—A few females, probably this species; Tepic, Oct., Nov.

205. *Misumena conferta*, sp. nov.

PLATE XVI, FIG. 12.

Length 5.4 mm.; ceph. 2.2 mm. long, broad 2 mm., femur I 3 mm. Cephalothorax uniform brown, whitish around the eyes; a large median white

spot pointed behind, in front indented by a dark line; anterior legs brown like the cephalothorax, paler on the middle of metatarsi and on base of tarsi, a pale line beneath on patellæ; the mandibles brown, white at tip, and a short line on the outer side at base; sternum and posterior legs pale yellowish; abdomen pale grayish, traces of dark stripes reaching from the middle above toward the spinnerets. Eyes of anterior row at equal distances, the four M. E. equal, forming a square; five bristles on each side of anterior margin, one at corner, the next smaller, the others much nearer to the middle; four pairs of spines under tibiæ I and II, six pairs under the metatarsi I and II; abdomen rather quadrate, pointed at tip.

One female; La Chuparosa. Distinguished by a dark cephalothorax, shape of pale spot, and dark front legs.

**206. *Misumena modesta*, sp. nov.**

PLATE XVI, FIG. 1.

Length ♀ 5-6.5 mm.; ceph. 2.8 mm. long, broad 2.7 mm.; femur I 3.5 mm. Cephalothorax brown or dark yellowish on the sides, behind is a white spot which extends forward each side; eyes on a white spot; a narrow white median line and side lines connect the eye-spot with the one behind; mandibles whitish, a large brown spot at the base; legs like the cephalothorax; sternum pale; abdomen yellowish, in one specimen a few indistinct dark spots behind the middle. Three bristles on each side on anterior margin of the cephalothorax, one at the corner and two nearer the middle. Legs rather short; four pairs of spines under the anterior tibiæ, six pairs under anterior metatarsi. Abdomen broadest somewhat behind the middle; sternum shield-shaped, concave in front, sides rounded. The ♂ is 3.5 mm. long; femur I 2.8 mm. long. Cephalothorax dark brown on the sides, white above, rather darker in front, with a median line; anterior legs red-brown, paler in middle of tibiæ, base of metatarsi, and tarsi; abdomen white, with a dark brown stripe on each anterior side, and above two stripes from the middle to the spinnerets; sternum dark, and a median stripe on the venter.

Several specimens; Sierra Laguna, La Chuparosa, and San Miguel de Horcasitas.

**207. *Misumena consueta*, sp. nov.**

PLATE XVI, FIG. 4.

Length ♀ 4.6 mm.; ceph. 2 mm. long, 2 mm. broad; femur I 2 mm. Cephalothorax and mandibles pale uniform greenish; legs still paler, the anterior pairs rather more greenish; sternum pale; venter pale gray, with a triangular outline of silvery dots with apex at the spinnerets; above rather brownish, with black marks, two large ones at base and several transverse ones behind, just before the middle two round white spots, and behind a larger median

one, and behind this a smaller one, everywhere with black bristles arising from black dots. Cephalothorax broad, but little narrowed in front; A. M. E. nearer to S. E. than to each other; S. E. on a little white elevation; four M. E. equal in size, forming a square; four bristles each side on front margin, one at corner, and three toward the middle. Legs short; four pairs of spines under tibiae and metatarsi I and II; sternum nearly circular. The epigynum shows a transverse curved cavity, behind it a dark transverse body, in front a rounded border, above which is a dark spot.

One female; Tepic, Oct.

**208. *Misumena decora*, sp. nov.**

PLATE XVI, FIG. 13.

Length ♀ 6 mm.; ceph. 2.5 mm. long, 2.6 mm. broad; femur I 3.9 mm. long. Cephalothorax pale, rather darker on the sides, a transverse white spot behind with an extension forward on each side, somewhat reddish between the M. E.; mandibles pale, with a brownish spot at the base; in most specimens the legs are all pale yellowish, with red spot on the anterior tibiae before the tip. In two specimens, which have deposited their eggs, the anterior femora, patellae, and tibiae are of a uniform pale red; sternum pale; abdomen whitish, marked above with red, a basal spot (mostly divided by a white line) followed by two converging rows of transverse spots, the basal pairs enclosing black dots, a red stripe on each anterior side, and on posterior sides oblique spots to the spinnerets. Eyes of anterior row at about equal distances; four M. E. equal and form a square; four bristles each side on anterior margin. Legs long; five or six pairs of spines under tibiae I and II, eight pairs under those metatarsi. The male is 3.2 mm. long; femur I 3.2 mm. long. Abdomen with two rows of dark spots above; femora I and II dotted with red, and red bands at the tip; also red at tip of patellae, base and tip of tibiae, and apical halves of metatarsi and tarsi. The style of the palpus is upon the ventral face, and not partly at right angles to it, as in many species.

Several specimens; El Taste, Sierra Laguna, and Sierra San Lazaro, Sept.

**209. *Misumena peninsulana*, sp. nov.**

PLATE XVI, FIG. 3.

Length ♀ 6-6.5 mm.; ceph. 2.4 mm. long, broad 2.4 mm.; femur I 3.2 mm. Cephalothorax, legs, mandibles, and sternum uniform pale yellowish, a white spot on middle scarcely distinct; abdomen whitish above and beneath, five impressed dots. Eyes of anterior row at equal distances; P. M. E. scarcely further apart than A. M. E.; four bristles each side on anterior margin. Legs moderate; four to five pairs of spines under anterior tibiae, seven

pairs under these metatarsi. Abdomen usually broadest behind the middle, pointed at the tip. The  $\delta$  is 2.9 mm. long; femur I 3 mm.; pale, sometimes indistinct spots on the abdomen; femora I and II not dotted, or but faintly, red band at tip, and at tip of patellæ, base and broad band at tip of tibiæ, apical halves of metatarsi and tarsi; palpi much like *M. spinosa*, the style short.

Various examples from El Taste, Sierra San Nicolas, Sierra Laguna, and San José del Cabo, Sept.

210. *Misumena* sp.?—Two specimens ( $\varphi$ ) from El Taste appear to be different from the others, but are rather uncertain. They are much like *M. peninsulana*, but plainly much smaller.

211. *Diæa damnosa* Keys.—Several specimens from Tepic, Oct. and Nov.

212. *Runcinia parva* Keys.?—Two immature females, probably this species: Tepic.

213. *Runcinia* sp.?—Two young females from Magdalena Island. White spot on the cephalothorax connected by a median line to the eye-region; on each side of the abdomen is a red stripe.

214. *Tmarsus magniceps* Keys.—One young specimen from San José del Cabo.

215. *Tmarsus separatus*, sp. nov.

PLATE XVI, FIG. 10.

Length 5 mm.; ceph. 2 mm. long, broad 1.8 mm.; femur I 2.4 mm. Cephalothorax brown, darkest behind and on the sides, a curved white line across the thoracic region, behind which is a small white spot, in front are three white lines, separated at base, and extending to the eye-region; a transverse line behind the P. M. E., a spot in front, and the anterior margin narrowly white. Legs pale yellowish, basal joints of anterior pairs (except

femur II) dotted with brown, a large spot at end of tibiae, and a narrow band at the tip of the metatarsi; usual black spot on patella IV, and a line on tibia, both margined in front with white; sternum pale, dotted with brown. Abdomen with a pale grayish dentated stripe in the middle above, and on the sides brown, below white, with a broad brown stripe in the middle, a short dark brown stripe reaching forward each side from near the spinnerets. P. M. E. much larger and farther apart than the A. M. E., the latter about as far from the A. S. E. as from each other; three large bristles each side on the anterior margin and one in the middle. Abdomen broadest behind the middle, pointed at tip; a well-developed cone above, and eight little elevations as follows: two before the middle, two just behind the middle, and four in a curved row before the hump.

One female: El Taste.

216. *Tmarsus*, sp.?—Young specimen from Tepic, Oct.

217. *Thanatus peninsulanus*, sp. nov.

PLATE XVI, FIG. 11.

Length ♀ 8 mm.; ceph. 2.5 mm. long, broad 2.6 mm.; femur I 3 mm. ♂ 5.5 mm., femur I 3.8 mm. long. Specimens often much larger, especially the abdomen. Cephalothorax pale yellowish, with a more or less distinct brownish stripe each side; mandibles, legs, and sternum pale, dotted with brown. Abdomen pale, a basal brown spear-mark, followed by two converging series of brown spots, sides dotted; venter with four brown lines; all markings variable in distinctness, sometimes running together, especially the legs, with browner lines and spots. A. M. E. fully as large as A. S. E., and their diameter apart, scarcely closer to the S. E.; eyes of posterior row equal and at about equal distances.

Many specimens from San José del Cabo.

218. *Ebo mexicana*, sp. nov.

PLATE XVI, FIG. 9.

Length 4 mm.; ceph. 1.5 mm, long, broad 1.5 mm.; femur I 1.8 mm., femur II 3.2 mm. long. Cephalothorax pale, with a large brown spot each side, not reaching behind to posterior margin, but extending down on the clypeus, each spot incloses a few white dots; a small median posterior spot, and two elongate spots behind the P. M. E. brown; mandibles pale, a brown spot at base and at tip. Legs pale, with brown bands on the middle and tip of femora, tip of patellæ, base and tip of tibiae, and base of metatarsi; on femur



If the bands are nearly united, on hind femora the middle band sometimes broken into dots; sternum pale, in one specimen with marginal dots. Abdomen with a basal brown spear-mark, margined with white, the white behind is a median stripe separating two dark stripes, thickly mottled with brown on anterior sides; venter pale, or slightly dotted with brown. The A. M. E. are much larger and closer together than the P. M. E., not much over their diameter apart, still closer to the smaller A. S. E.; P. M. E. much nearer to the P. S. E. than to each other; two pairs of long spines under tibia and metatarsus I; abdomen broadest in the middle, pointed behind.

Two female specimens from Hermosillo.

### SPARASSIDÆ.

**219. *Heteropoda venatoria* Linn.**—Many specimens from San José del Cabo; a few from Tepic.

**220. *Olios fasciculatus* Sim.**—Several from San José del Cabo. I think that *O. concolor* and *O. giganteus* Keys are this species.

**221. *Olios peninsulanus*, sp. nov.**

PLATE XVI, FIG. 19.

Length ♀ 13 mm.; ceph. 4.3 mm. long, broad 3.9 mm.; femur I 4.5 mm. Cephalothorax, legs, mandibles, and sternum pale yellowish; fangs dark red-brown; abdomen light gray above and below, with a more or less distinct median row of brown dots above. The cephalothorax is convex, highest a little behind the eyes; posterior row straight, plainly longer than the anterior row, equal in size and at nearly equal distances; the M. E. twice their diameter apart; A. M. E. larger, once their diameter apart, plainly closer to the equal A. S. E.; mandibles short, prominent. Legs moderately short; two pairs of spines under all tibiæ and metatarsi; sternum broader than long, triangular, pointed between hind coxæ. Abdomen rather large, oval, rounded at base, pointed at tip. The ♂ is similar to the ♀, but smaller and proportionally longer legs; the tarsus of the palpus blackish.

Several specimens; Sierra San Lazaro and San José del Cabo.

**222. *Olios luctuosa*, sp. nov.**

PLATE XVI, FIG. 15.

Length ♀ 11.5 mm.; ceph. 4.9 mm. long, broad 4.6 mm.; femur I 5.6 mm. Cephalothorax, mandibles, sternum, and legs pale yellowish, the latter with the metatarsi and tarsi darker; fang red-brown. Abdomen pale gray above, with a median row of black spots in the posterior half, and numerous small blackish dots, most numerous behind; venter spotted, and with a broad black stripe from furrow to spinnerets, broadest at base. Cephalothorax highest at posterior part of pars cephalica; posterior eye-row straight, equal, M. E. fully twice their diameter apart, scarcely so far from the S. E.; A. M. E. larger, fully their diameter apart, closer to the slightly smaller A. S. E.; mandibles short and stout; sternum broader than long, triangular, sides slightly rounded. Legs moderate; two pairs of spines under all tibiae and metatarsi. Abdomen not very large, rather truncate at base, blunt-pointed at tip, somewhat depressed.

Two adults and several young from Tepic, Nov.

**223. *Olios ferrugineus* Koch.—One female, from Tepic.****224. *Selenops debilis*, sp. nov.**

PLATE XVI, FIG. 14.

Length ♀ 11 mm.; ceph. 4.2 mm. long, broad 4.5 mm.; femur I 4.8 mm. Cephalothorax, sternum, and legs pale yellowish, the former with a black seam, the latter with dark spots at base and beyond the middle of the femora and tibiae, most distinct on the underside and on the anterior pairs; mandibles rather reddish. Abdomen pale gray, darker on each posterior side, and sometimes dark patches above. The A. M. E. about their diameter apart, plainly closer to the very much larger P. M. E., which are fully twice their diameter from the larger P. S. E.; sternum scarcely longer than broad, slightly narrowed in front, blunt behind. Legs short; three pairs of spines under tibiae I and II, two pairs of small spines under tibiae III and IV. Abdomen broad, truncate at base, broadest behind the middle, broadly rounded behind.

Two females and several young; San José del Cabo.

**225. *Selenops* sp.?**—Many specimens from San José del Cabo. These may be *debilis*, but all are immature; some, however, are larger than adult *debilis*; the abdomen is darker.

**226. *Selenops morosa*, sp. nov.**

PLATE XVI, FIG. 16.

Length ♀ 17 mm.; ceph. 8 mm. long, broad 8 mm.; femur I 9.5 mm. Cephalothorax, sternum, and legs pale yellowish, a black seam to cephalothorax, black bands at bases and beyond middles of tibiae I, II and III, metatarsus I and II infuscated, and some spots on the femora; mandibles red-brown, paler at base. Abdomen dark gray above, paler beneath. Cephalothorax flat, highest in eye-region, groove quite long; A. M. E. less than their diameter apart, rather closer to the plainly larger P. M. E.; the latter a little smaller than the P. S. E., from which they are separated by once and a half their diameter. Legs long, but quite stout; three pairs of spines under tibiae I and II, two pairs under III and IV; sternum plainly longer than broad, sides rounded, slightly narrowed in front, blunt behind. Abdomen short, depressed, truncate at base, pointed at tip. Male similar, but rather paler and markings less distinct; 13 mm. long.

Several specimens from Tepic, Oct. and Nov.

## LYCOSIDÆ.

**227. *Lycosa scutulata* Hentz.**—Young from Tepic.

**228. *Lycosa coloradensis* Bks.**—One male from Hermosillo; a female (not quite adult), probably this species, from San Miguel de Horcasitas.

**229. *Lycosa grandis* Bks.**—San José del Cabo; the southwestern representative of *L. babingtoni*.

**230. *Lycosa adusta*, sp. nov.**

PLATE XVI, FIG. 31.

Length ♀ 11 mm.; ceph. 4.7 mm. long, broad 3.6 mm.; tibia and patella IV 3.6 mm. Cephalothorax pale red-brown, rather lighter in spots toward the sides; above a median pale stripe, starting quite broad between the eyes, gradually widening, and then contracted before the groove and tapering to the hind margin; mandibles red-brown; sternum and legs yellowish, no marks; abdomen dark brown above, uniformly dotted with very small pale dots; venter much lighter; epigynum reddish. Cephalothorax rather low; anterior eye-row barely curved, a trifle shorter than second row. Legs very

short and the femora stout; tibia III not much more than twice as long as broad; sternum plainly longer than broad. Abdomen rounded at base, pointed at tip, about twice as long as broad.

One female; San Miguel de Horcasitas.

ris, sp. nov.

26.

5 mm.; tibia plus patella IV round eyes, a narrow pale stripe as a line from between the A. and coxæ light red-brown; legs bands; abdomen dark brown surrounded by pale, which displays scattered black dots. First the second. Legs very short tibiæ, the basal pairs on anterior abdomen high, rounded at base,

or, sp. nov.

25.

broad 7.5 mm.; tibia plus patella above light yellow-brown, darker tarsi blackish beneath, and a dark red-brown, with a few yellowish blackish; venter black; abdomen tripe, sparsely clothed above with curved, shorter than the second, art. Legs stout and moderately pairs under all tibiæ; distinct and tarsi. Abdomen rounded at small.

Tepic, Nov. The young

icta, sp. nov.

Fig. 30.

broad 7.8 mm.; tibia plus patella paler on the sides, no distinct markings; mandibles dark red-brown; sternum, coxæ, and legs light reddish,

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the latter darker toward tip, no bands; abdomen black, two short narrow stripes on the basal part above, behind some transversely connected spots, pale; venter black. First eye-row nearly straight; the M. E. plainly larger than the S. E. Legs moderately stout; three pairs of spines under all tibiae; the apical pair but little shorter than the others. Abdomen short, rounded at base and tip.

Two specimens; San José del Cabo.

234. *Lycosa persimilis*, sp. nov.

PLATE XVII, FIG. 2.

Length 16 mm.; ceph. 6.9 mm. long, broad 5 mm.; tibia plus patella IV 7.1 mm. Cephalothorax pale yellowish or reddish, an irregular brown stripe each side, terminating behind in a darker spot, the pale space of nearly equal width throughout, but starting between the eyes as a white line; eyes on black spots; mandibles dark red-brown, clothed with tawny hairs. Legs paler yellowish brown, the hind tibia with a dark band at base and tip; sternum, coxae, and venter wholly jet black. Abdomen above light brownish, with a dark basal spear-mark, and behind spots or chevrons of pale; sides pale. First eye-row curved, plainly shorter than the second, the latter their diameter apart. Legs of moderate length; three pairs of spines under all tibiae; sternum plainly longer than broad. Abdomen rounded at base, pointed at tip, quite high and convex. The  $\delta$  smaller, 10 mm. long; colored like the  $\varphi$ , but the legs paler and with distinct dark bands at base and ends of tibia IV.

Many specimens from Tepic, Oct. and Nov., and San José del Cabo, the latter are rather larger than the others; the specimens not quite mature are larger than the adult ones. A species similar to *L. erratica* Hentz.

235. *Lycosa injusta*, sp. nov.

PLATE XVII, FIG. 1.

Length  $\delta$  22 mm.; ceph. 11.5 mm. long, broad 8.5 mm.; tibia plus patella IV 13 mm. Cephalothorax red-brown, the radial furrows darker, a narrow pale stripe in the middle and another each side; mandibles dark red-brown, with tawny hair. Legs light brownish, the tibiae and metatarsi of anterior pairs darker, all clothed above with white hair, but below the femora are brown at tips, the patellae wholly white, the tibiae brown at bases and tips, and the metatarsi slightly brownish; sternum and coxae are dark brownish, which color extends over the venter to the furrow and gives off behind two

short projections upon the pale venter; brown at base of the spinnerets. Abdomen light brown above, with darker spots, and two larger ones at base; ♂ palpus pale except the brown tarsus. First eye-row curved, plainly shorter than the second. Legs long and stout; three pairs of nearly equal spines under all tibiae, hair under tibiae and tarsi of anterior pairs so dense as to almost form scopulas; sternum not much longer than broad. Abdomen short, pointed at base and behind, not depressed.

One male; Hermosillo; a female, probably of this species (immature), from San Miguel de Horcasitas is colored about the same, but the anterior tibiae are scarcely darker than the femora.

**236. *Lycosa futilis*, sp. nov.**

PLATE XVI, FIG. 32.

Length ♀ 11.2 mm.; ceph. 5.8 mm. long, broad 4.2 mm.; tibia plus patella IV 5.8 mm. Cephalothorax pale yellow-brown, a faint narrow pale stripe each side, and a narrow median one starting as a line between eyes of second row, gradually widening to the groove, then tapering to the hind margin; eyes on black spots, radial furrows darker than elsewhere; mandibles reddish; sternum and legs pale yellowish, no markings. Abdomen with a basal dark, almost blackish, spear-mark reaching to the middle of the dorsum, surrounded by pale which is continued, as two rows of spots, to the tip, each side of the pale is an irregular brown stripe; sides and venter pale. Anterior eye-row curved, a little shorter than the second row. Legs short; three pairs of nearly equal spines under all tibiae. Abdomen subcylindrical, broadly rounded at tip, subtruncate at base. The ♂ is similar to the ♀ but a little smaller; the palpi wholly pale and very short.

Agua Caliente, Orizaba, Motzoronga, and Tepic, Oct. Two specimens from San José del Cabo are rather darker and have an irregular black spot on the basal part of the venter.

**237. *Lycosa mexicana*, sp. nov.**

PLATE XVII, FIG. 3.

Length ♀ 16 mm.; ceph. 7 mm. long, broad 4.8 mm.; tibia plus patella IV 7 mm. Cephalothorax dark red-brown, a broad stripe of white hair above, broad as the space between dorsal eyes, then tapering behind to a point; mandibles almost black; sternum and coxae blackish; legs reddish brown, no marks; abdomen dark brown above, a basal black spot each

side extending back as a stripe on the upper side, but rather indistinct, the space between and below paler; venter black. Anterior eye-row slightly curved, a trifle shorter than the second row; three pairs of spines of nearly equal size under all tibiae. Abdomen rather long, subcylindrical, pointed at tip, rounded at the base. The  $\delta$  is similar, but a little smaller, and the black side-stripes on the abdomen more distinct; the palpus pale, except the tarsus, which is dark.

A pair from Mt. Orizaba, and a male from Vera Cruz (rather paler).

238. *Lycosa* sp.?—One female from Minititlan, much like *L. mexicana*, but the venter pale, possibly only a variety of that species.

239. *Diapontia* sp.?—Many young specimens from Tepic and San José del Cabo. It has a dark cephalothorax, with a narrow pale stripe each side, and a narrow black median stripe on dorsum of the abdomen.

240. *Trochosa cinerea* Fabr.—Many specimens from San José del Cabo, Sierra San Lazaro, Ensenada, Tepic, Mt. Orizaba, and Vera Cruz.

241. *Trochosa parva* Bks.—Three specimens from Tepic, and two without locality, probably from Baja California.

242. *Trochosa mexicana*, sp. nov.

PLATE XVII, FIG. 4.

Length ♀ 9 mm.; ceph. 5 mm. long, broad 3.9 mm.; tibia plus patella IV 5.5 mm. Cephalothorax pale yellowish, an irregular brown stripe each side, and the margins dark, eyes on black spots; mandibles rather reddish; sternum and legs pale yellowish, the latter with dark bands on the femora, most distinct on the under side, sometimes also on the tibiae. Abdomen blackish above, with a narrow basal spear-mark of pale, and some spots each side of it; venter pale brownish. Cephalothorax low in front, sides much sloping, first eye-row no longer than the second, dorsal eyes considerably farther apart than those of second row. Legs short, except the fourth pair, femora very stout, three pairs of spines under all the tibiae; sternum

nearly as broad as long. Abdomen short, subtruncate at base, broadly rounded at the tip; epigynum shows a transversely elliptical cavity behind a hard reddish plate.

Four females from Tepic, Oct.

**243. *Aulonia* (?) *funerea* Hentz.**—Several examples from Tepic.

**244. *Pardosa milvina* Hentz.**—Many specimens from Tepic, Oct. and Nov., and Orizaba.

**245. *Pardosa sabulosa*, sp. nov.**

PLATE XVI, FIG. 28.

Length ♀ 5.5 mm.; ceph. 2.4 mm. long, broad 2 mm.; tibia plus patella IV 3.1 mm. Cephalothorax dark brown, black in eye-region, a broad pale spot in middle, truncate in front, pointed behind; mandibles red-brown; sternum blackish; legs yellow-brown, paler on tips. femora with a pale spot across middle above; abdomen black, a basal broad pale spot and behind two rows of connected spots; venter light brown. Three pairs of long spines under tibia I, and a short pair at tip; sternum about as broad as long; abdomen rather depressed, broad, truncate at base, pointed at tip.

Three examples from Tepic, Nov.

**246. *Pardosa medialis*, sp. nov.**

PLATE XVI, FIG. 29.

Length 4.5 mm.; ceph. 2.1 mm. long, broad 1.6 mm.; tibia and patella IV 2.9 mm. Cephalothorax pale yellowish, black around the eyes, two broad straight brown stripes above, leaving a narrow median pale area, which is divided by a dark line, a few black dots near the margin; mandibles, sternum, and legs pale yellowish, the latter without bands, but darker at tips of hind tibiae and tarsi; abdomen blackish above, with a pale median line from base to tip, its posterior portion margined with geminate spots; venter pale; epigynum reddish. Three pairs of long spines under tibiae I and II, and a short pair at tip; sternum about as broad as long; abdomen truncate at base, pointed at the tip.

One specimen; Tepic, Oct.



**247. *Pardosa futilis*, sp. nov.**

PLATE XVI, FIG. 23.

Length ♀ 7.2 mm.; ceph. 3.7 mm. long, broad 3.1 mm.; tibia plus patella IV 4.1 mm. Cephalothorax red-brown, darker in the eye-region, a pale stripe behind indistinct; mandibles brown; sternum black; legs pale, with broad black bands, except on the tarsi; abdomen mostly blackish, reddish basal spot; venter light brown. The cephalothorax is rather broad; the legs of moderate length, three pairs of long spines under tibia I and a short pair at tip; abdomen quite broad. The ♂ is similar to the ♀, but darker, mostly black; legs, except femora and hind tibiae, wholly pale; palpi black.

Three examples from San José del Cabo.

**248. *Pardosa dilecta*, sp. nov.**

PLATE XVI, FIG. 24.

Length ♀ 8 mm.; ceph. 3.5 mm. long, broad 3 mm.; tibia plus patella IV 4.8 mm. Cephalothorax red-brown, black in the eye-region, an indistinct median pale stripe behind, whole surface clothed with white hair; mandibles light brown; sternum black; legs brownish, yellowish toward the tips, the femora above with elongate pointed pale spots; abdomen black above and on the sides, scarcely showing a reddish basal spot; venter light brown. Cephalothorax rather broad, much narrowed in front. Legs moderate, fourth pair very long; two pairs of spines under tibia I and a short pair at tip. Abdomen truncate at base, pointed at the tip, rather broad and depressed.

One female; Baja California, no further locality.

**249. *Pardosa sierra*, sp. nov.**

PLATE XVI, FIG. 20.

Length ♀ 5.6 mm.; ceph. 2.6 mm. long, broad 2.2 mm.; tibia plus patella IV 4 mm. Cephalothorax dark brown, black in the eye-region, a few pale side-spots and short central stripe, constricted in front and pointed behind; mandibles pale brown; sternum brown; legs pale, dark bands on the femora; abdomen with a pale basal spot, behind two series of small spots, the posterior ones united, sometimes all run together in a broad irregular pale stripe, elsewhere black; venter light brown. Cephalothorax short; legs quite long; three pairs of long spines under tibia I, and a short pair at tip; abdomen short and broad. The ♂ is similar to the ♀, but smaller; palpi wholly black.

Four specimens from Sierra Laguna.

**250. *Pardosa peninsulana*, sp. nov.**

PLATE XVI, FIG. 22.

Length ♀ 7.5 mm.; ceph. 3 mm. long, broad 2.3 mm.; tibia plus patella IV 4 mm. Cephalothorax dark brown, a narrow pale stripe each side extending from the anterior to the posterior margin, side-margin dark brown, a pale narrow middle stripe, containing a median brown line, divided in front into three parts or broken into three spots; mandibles pale; sternum dark brown, usually with a median pale line and sometimes pale borders. Legs pale, with short brown stripes on the femora above; coxæ black above; abdomen blackish above, with a pale basal spear-mark, and behind some indistinct dots; venter pale. Cephalothorax slender; legs rather short except the hind pair, two pairs of long spines under tibia I and a short pair at tip; abdomen rather slender, rounded at base. The male is similar to the female, but is smaller, and the dark markings more extensive; the male palpus is black on the tarsus, pale elsewhere; venter sometimes infuscated and also under side of the coxæ.

Several specimens from the Cape Region.

**251. *Pardosa bellona*, sp. nov.**

PLATE XVI, FIG. 21.

Length ♀ 5.1 mm.; ceph. 2.5 mm. long, broad 2 mm.; tibia plus patella IV 3.3 mm. Cephalothorax pale, a blackish serrate stripe each side and a few dots along the margin; eye-region blackish, pale in the middle; clypeus pale; mandibles pale, with an elongate black spot at the base; sternum and coxæ below pale yellow. Legs pale, with numerous blackish bands on all joints except tarsi; abdomen whitish, a blackish stripe each side formed of irregular dots, a basal yellowish spear-mark; venter pale; epigynum reddish. Cephalothorax moderately long, narrow in front; three pairs of long spines under tibia I and a short pair at tip; abdomen rather narrow, subcylindrical. The ♂ similar to ♀; the cephalic markings larger and darker; mandibles black; the palpi black, the femur and patella clothed with white hair, the tibia and tarsus with dense black hair; coxæ I and basal half of femur I black, and sometimes a large black spot on front of femur II, rest of legs banded as in ♀; abdomen black, with a narrow pale stripe; venter pale. Some males are colored more like the females than others.

Several specimens from San Miguel de Horcasitas, Magdalena Island, Coral de Piedras, and San José del Cabo.

**252. *Pardosa parallela*, sp. nov.**

PLATE XVI, FIG. 27.

Length ♀ 6 mm.; ceph. 3 mm. long, broad 2.1 mm.; tibia and patella IV 4 mm. Cephalothorax pale, a straight dark brown stripe each side; eye-region black, some white hairs in the middle; clypeus black, posterior sides narrowly brown; mandibles red-brown; sternum pale yellow; legs yellowish at base, gradually becoming more red-brown toward the tips, but tarsi pale, without trace of bands; abdomen black above, a pale basal spear-mark and beyond two approximate rows of small pale spots; venter pale, epigynum reddish. Cephalothorax long and slender, much narrowed in front; legs long, two pairs of long spines under the anterior tibia and a short pair at tip; abdomen short, subcylindrical, hardly broader than the cephalothorax.

Several females from Sierra San Lazaro, Sept.

**253. *Pardosa*, sp.?**—One female from Vera Cruz, not sufficiently distinct for description.

**254. *Dolomedes major*, sp. nov.**

PLATE XVII, FIG. 5.

Length ♀ 24 mm.; ceph. 11 mm. long, broad 9 mm.; femur I 10 mm. Cephalothorax yellow-brown, with a narrow yellow stripe each side, a pale median line from the groove to the P. M. E., and often showing a curved line behind the P. S. E.; mandibles red brown; sternum pale, with brown spots around the sides. Legs yellow-brown, darker toward the tips, without bands; abdomen brown, rather blackish above, a pale indistinct basal spear-mark and a submedian row each side of five white dots, and a short whitish stripe on each posterior side. A. M. E. plainly larger than A. S. E.; eyes of posterior row about equal. Legs very stout; four pairs of spines under anterior tibiae. Abdomen rather high, once and two-thirds as long as broad. The ♂ is similar but smaller, 17 mm. long, especially the abdomen, and proportionally longer legs; the hind femur has below at its apical third a prominent stout spur tipped with many short black spines; the general color is paler and the white dots surrounded by black. One ♀ is almost black, but does not differ structurally.

Many specimens from San José del Cabo and Sierra San Lazaro.

**254a. *Dolomedes major*, var.**—Two males from San José del Cabo are a little smaller than the others and the

projection on the tibia of the palpus is not near as much widened at tip. They have the characteristic spur on the hind femur.

**255. *Dolomedes minor*, sp. nov.**

PLATE XVII, FIG. 6.

Length ♀ 14 mm.; ceph. 6 mm. long, broad 5 mm.; femur I 8.5 mm. Cephalothorax pale yellow-brown, darker above and on the margin, a narrow white stripe each side from anterior to posterior margin, a white spot in middle of clypeus, a pale line from groove to P. M. E., and lines behind the P. S. E.; mandibles pale yellowish, clothed with long white hair; sternum pale, indistinctly darker on the sides. Legs pale yellow-brown, darker toward tips; the femora show indistinct darker bands above. Abdomen light brown, with a broad dark brown stripe above, narrow and indented toward the tip, its base containing a pale spear-mark. A. M. E. larger than A. S. E.; P. S. E. scarcely larger than P. M. E. Legs long and slender; four pairs of long spines under the anterior tibiae and a short pair at tip. Abdomen depressed, once and three-fourths as long as broad, rather truncate at the base. The ♂ is smaller than the ♀, 10 mm. long, with a much narrower abdomen, paler and proportionally longer legs.

Many specimens from San José del Cabo, Guaymas; Sierra San Lazaro, Sept.; and Tepic, Oct.

CTENIDÆ.

**256. *Ctenus hibernalis* Hentz.**—A few from Minititlan, Orizaba, and La Chuparosa.

**257. *Ctenus punctulatus* Hentz.**—A few from Tepic in Nov.

**258. *Ctenus* sp.?**—A large female (not quite adult) from Minititlan differs from either of the above species.

**259. *Acanthoctenus spinigerus* Keys.**—Several specimens from Minititlan, Orizaba, and Mexico City.

## OXYOPIDÆ.

260. *Peucetia viridans* *Hentz.*—Many specimens from San José del Cabo, Oct. and Nov. Some of them are quite reddish.

261. *Hamataliwa grisea* *Keys.*—One specimen from San José del Cabo.

262. *Oxyopes flava*, sp. nov.

PLATE XVII, FIG. 28.

Length 7.5 mm. Cephalothorax; mandibles, legs, palpi, and sternum yellow; eyes on black spots, a black line from each anterior eye down upon mandibles; base of spines on legs black; some spatulate scales on the cephalothorax. Abdomen usually paler yellow, with a gray spear-mark at base, and a black stripe each side near tip, sometimes very short; venter with a broad black median stripe, black spot over epigynum; spinnerets yellow, lined with black. Cephalothorax high, from eyes to dorsal groove barely concave, behind steeply sloping; eyes about as usual, P. M. E. hardly three times their diameter apart. Legs with many spines arranged as in *O. salticus*.

A few specimens from Sierra San Lazaro, Sept.; San José del Cabo, Sept.; and Tepic, Oct. Related to *O. salticus*, but readily separated by brighter yellow color, no black stripe on legs, larger size, and different epigynum.

263. *Oxyopes brevis*, sp. nov.

PLATE XVII, FIG. 26.

Length 4.5 mm. Cephalothorax dull yellowish, clothed with white scales, a median narrow white stripe on clypeus and a broader one each side; eyes on black spots; in some specimens there is a darkish spot on each posterior side of cephalothorax; mandibles yellowish, clothed with short white scales; sternum and legs pale yellowish, the latter sometimes with brown bands on the middle of the joints, clothed with some scales, fine hairs, and many stout spines. Abdomen dull yellowish, clothed with scales above and on sides, hairs below, a dark stripe on each lower side and one on middle of venter. Cephalothorax short and high, straight from eye-region to dorsal groove; eyes about as usual; P. M. E. fully three times their diameter apart. Legs short and stout; sternum triangular, but little longer than broad. Abdomen short,

once and one-fourth as long as broad, blunt pointed behind. Epigynum shows a cavity broader than long, limited on sides and behind by a black ridge and divided by a pale septum.

Four specimens; El Taste.

**264. *Oxyopes acutus*, sp. nov.**

PLATE XVII, FIG. 27.

Length 7 mm. Cephalothorax dull yellowish, thickly clothed with white scales, as also rest of body; eye-region black, a brown stripe each side above not reaching to the posterior margin, and one each side on the clypeus extending down upon the mandibles; sternum pale; legs pale at base, darker on tibiae, metatarsi, and tips of the femora; abdomen pale grayish, a spear-mark at base, and an irregular dark stripe more or less distinct on each upper side reaching from base to tip; venter with a broad brown stripe from base to spinnerets. Cephalothorax high, highest in the eye-region, concave from there to dorsal groove; P. M. E. hardly three times their diameter apart; a few curved bristles each side of eye-region. Legs as usual, spines very long; sternum plainly longer than broad. Abdomen about once and two-thirds as long as broad in ♀, contracted near tip, ending in a quite acute point; in a young ♂ it is two and a third times as long as broad.

Young specimens from La Chuparosa, Sierra Laguna, and Hermosillo; adult female from California.

**PODOPHTHALMIDÆ.**

**265. *Podophthalma*, sp.?**—Several broken specimens without locality.

**ATTIDÆ.**

**266. *Phidippus arizonensis* Peck.**—Two females from Agua Caliente, and one from Tepic, belong to this species. The abdomen is red above, a basal white band, a median white spot followed by a black stripe to the tip, an interrupted, curved white band, and two spots before the tip, and an oblique white band each side, near the middle.

**267. *Phidippus mexicanus* Peck.**

♀ 11 mm. long; ceph. 5 mm. long, red-brown, clothed with white hairs on the sides; a tuft of black bristles above eyes of the second row; palpi and clypeus with long white hair; mandibles brilliant green; legs red-brown, blackish at ends of joints, tarsi pale, clothed with white hair, more blackish under tip of tibia I; abdomen with a broad black field on venter, margined with pale, above rather reddish around sides, black above, a basal white band, a large median triangular white spot, and behind it two pairs of transverse white spots; IV metatarsi have a spine near middle.

Two females from Tepic and one from El Taste, with shrunken abdomens, appear to belong here.

**268. *Phidippus georgii* Peck.**

PLATE XVII, FIG. 23.

Several specimens from Tepic. The dark median stripe is really a slightly paler folium margined with black; metatarsi IV have two spines near the middle.

**269. *Phidippus nigropilosus*, sp. nov.**

PLATE XVII, FIG. 20.

Length 12 mm.; ceph. 5.7 mm. long, broad 4.4 mm. Dark red-brown all over, almost black, especially on the under side; the tarsi pale and palpi lighter reddish, clothed with long black hair, denser on tibia I; some white hair over A. M. E.; some iridescent scales on eye-region and on the dorsum of abdomen. Anterior row of eyes curved; S. E. hardly half their diameter from the M. E.; mandibles transversely rugose toward tip; metatarsus IV spined near middle, no spines above on tibia IV.

Two females from Tepic, Nov.

**270. *Phidippus funebris*, sp. nov.**

PLATE XVII, FIG. 22.

Length ♀ 13.5 mm.; ceph. 5.3 mm. long, broad 4.2 mm. Cephalothorax, mandibles, sternum, and legs dark red-brown, tarsi pale; abdomen black, clothed with black hairs, some small white spots on the sides and four pairs above; dorsum with iridescent scales, also some on eye-region; venter black,

hardly paler on sides, the black hair is very dense under tibia I; metatarsi IV rather long, a spine before middle. In ♂ (10.5 mm. long) the mandibles are large, porrect, divergent, and polished, the fang is undulate and has a buccal tooth near middle; two large teeth on base of mandibles, and a blunt process above and below near base of fang. The anterior legs are longer than in the ♀ and more densely black haired.

One pair from Tepic, Oct. Known by black hair, dark color, and spots on sides of abdomen.

### 271. *Phidippus fraternus*, sp. nov.

PLATE XVII, FIG. 24.

Length ♀ 11-12 mm.; ceph. 5 mm. long, broad 4 mm. Cephalothorax red-brown, sides clothed with white hair, blackish on eye region, with some iridescent scales; clypeus and palpi long, white haired; mandibles reddish, polished; sternum red-brown; legs reddish, tarsi pale, anterior pair darkest, most of joints darker at tips, all with long white hair, except black at tip of tibia I; abdomen clothed above with bright bronze or coppery scales, air rounded by a white band (in some specimens reddish) and three pairs of white dots above; venter with three dark lines; hind metatarsi with one spine in front before tip, none below. The ♂ is 8.5 mm. long; the cephalothorax, mandibles, and legs dark red-brown or almost blackish; abdomen dark reddish, with iridescent scales above and a narrow white stripe around sides (sometimes broken toward spinnerets into spots) and three pairs of white dots above. Mandibles long, scarcely porrect, a tooth below at base, long short, evenly curved.

Various specimens from El Taste, Sierra San Nicolas, Sierra San Lazaro, and a large male from Magdalena Island.

### 272. *Phidippus disjunctus*, sp. nov.

PLATE XVII, FIG. 25.

Length ♂ 10.5 mm. ceph. 5 mm. long, broad 4 mm. Cephalothorax red-brown, sides clothed with white hair, blackish on eye region, with some iridescent scales; clypeus and palpi long, white haired; mandibles reddish, polished; sternum red-brown; legs reddish, tarsi pale, anterior pair darkest, most of joints darker at tips, all with long white hair, except black at tip of tibia I; abdomen clothed above with bright bronze or coppery scales, air rounded by a white band (in some specimens reddish) and three pairs of white dots above; venter with three dark lines; hind metatarsi with one spine in front before tip, none below. The ♀ is 8.5 mm. long; the cephalothorax, mandibles, and legs dark red-brown or almost blackish; abdomen dark reddish, with iridescent scales above and a narrow white stripe around sides (sometimes broken toward spinnerets into spots) and three pairs of white dots above. Mandibles long, scarcely porrect, a tooth below at base, long short, evenly curved.



middle field clothed with iridescent scales. Cephalothorax large and heavy; anterior eye-row curved; S. E. distant from M. E.; eyes of second row about twice as far from dorsal as from lateral eyes; metatarsi IV spined only at tip, no spines above on tibia IV.

Two females from Tepic, Oct. In markings it is very similar to *Philæus multicolor*, but its large size at once separates it.

**273. *Philæus multicolor* Hentz.**—One female from Tepic, Oct.

**274. *Philæus limbatus*, sp. nov.**

PLATE XVII, FIG. 17.

Length ♂ 4.5 mm. Cephalothorax black on sides and behind, above clothed with iridescent greenish scales, a white stripe starts from the lateral eyes and extends to the thoracic region; mandibles dark red-brown; legs brown, posterior coxæ, intermediate metatarsi, and all tarsi pale; sternum brown; abdomen above brown, clothed with iridescent greenish scales, a white stripe around base and on the sides, not reaching to the tip, below this the sides are black; venter brown, except base which is paler. Mandibles long, porrect, diverging, armed toward base above with a spine and near tip below a still larger one; fang long and curved at base. Legs short; first pair stoutest and longest; three pairs of spines under tibia I toward tip, and two pairs under metatarsi I; coxæ I separated by width of lip; tarsus of ♂ palpus truncate at tip and clothed with white hair.

Three males; Tepic, Nov.

**275. *Philæus trimaculatus*, sp. nov.**

PLATE XVII, FIG. 18.

Length ♂ 5.2 mm. Cephalothorax black, a spot in front of each dorsal eye, a median spot behind, and the posterior sides narrowly white, some iridescent scales in eye-region; mandibles and anterior legs wholly red-brown, a white stripe above on palpus; coxæ II, III, and IV, bases of femora III and IV, and intermediate tarsi pale, rest red-brown, in ♀ the posterior tibiæ paler in the middle; sternum red-brown; abdomen brown, clothed with greenish scales above, a basal curved white band, in front of which the abdomen is black, a median and a subapical pair of transverse white spots, and two white dots in front; venter rather paler on the sides, in the ♀ the white spots

are edged with black, and sometimes nearly meet above; some white scales on legs, anterior pair of  $\delta$  with long and short black hair. Mandibles of  $\delta$  vertical, unarmed, fang short; coxæ I separated by fully width of labium; leg I much the stoutest and longest, three pairs of spines under tibia, two under metatarsi.

One male and several females, which, however, are scarcely adult, from Tepic, Oct.

**276. *Philæus consimilis*, sp. nov.**

PLATE XVII, FIG. 13.

Length  $\delta$  5.2 mm. Very similar to *P. limbatus*, but larger and rather paler. Cephalothorax clothed with iridescent scales, and abdomen also as in that species, with a white band around sides; metatarsus I is pale at base (in *limbatus* wholly black), and the metatarsus IV is wholly pale (in *limbatus* wholly black). The  $\delta$  mandibles are long and divergent as in *P. limbatus*, and armed with a tooth below at tip and a smaller one near base, the fang straight. The  $\varphi$ , 6.5 mm. long, has a red-brown cephalothorax, with iridescent scales. Abdomen brown above, clothed with iridescent scales, a white line around base, below this the sides are black, rather paler in the venter; legs red-brown; the distal joints paler, often darker at the tip.

Two pairs from Coral de Piedras.

**277. *Dynamius opimus* Peck.**

PLATE XVII, FIG. 25.

One specimen from Tepic.

**278. *Helorus perditus*, sp. nov.**

PLATE XVII, FIG. 19.

Length  $\delta$  7 mm.; ceph. 3.5 mm. long, broad 2.3 mm. The cephalothorax is red-brown, blackish in the eye-region, a white stripe from lateral eyes back just below dorsal eyes, then extending across to meet the one from the other side; mandibles light red-brown; palpi black haired on femora and tarsus, on patella thick white hair, very long at tip; legs yellow-brown, rather blackish on femur I, tarsi pale; sternum yellowish; abdomen black, a white band at base and an indistinct pale median stripe formed of chevrons, and a white dot each side of it toward apex; venter pale, with black dots. The eyes of second row are about one-half way between dorsal and lateral eyes. The third legs are as long as the fourth; posterior metatarsi spined to base. The  $\delta$  palpi

are small; the tarsus shorter than the tibia. The ♀ is similar to the ♂, 8 mm. long. The abdomen is paler and the median stripe is margined with black, and there are no dots on the venter; the epigynum is very small.

One pair from Tepic, Nov.

279. *Dendryphantes nubilus* *Hentz.*—Many specimens from Tepic.

280. *Dendryphantes retarius* *Hentz.*—Several specimens from Tepic and Sierra San Lazaro, Sept.

281. *Dendryphantes vitis* *Cock.*—A few specimens from San José del Cabo.

282. *Dendryphantes*, sp.?—One female from Tepic. Abdomen pale above, but with iridescent scales, blackish on the sides; cephalothorax, sternum, and legs red-brown; hind pairs paler.

283. *Pachomius niger*, sp. nov.

PLATE XVII, FIG. 15.

Length ♀ 6 mm.; ceph. 2.7 mm. long, broad 1.8 mm. Cephalothorax dark red-brown, black on eye-region; mandibles and sternum dark red-brown; legs paler red-brown, tarsi yellowish; abdomen black; epigynum reddish. Cephalothorax long and flat; abdomen slender, broadest in middle, tapering both ways; legs short, first pair much the stoutest, metatarsus IV with two spines below near middle.

One example from San José del Cabo.

284. *Marptusa californica* *Peck.*—One specimen from San José del Cabo.

285. *Marptusa familiaris* *Hentz.*—A few specimens from Minititlan.

**286. *Marptusa melanognatha* Luc.**—Many specimens; San José del Cabo, El Taste, Minititlan, Coral de Piedras, and Hermosillo.

**287. *Cyrba* sp.?**

Length 3.5 mm. (young ♂). Blackish; palpi pale; first legs, except tarsi, black; others pale, except the femora black, and a black line on each side of metatarsi IV. Abdomen with a basal band reaching to posterior third, above two parallel stripes to posterior third, and behind two oblique spots. Cephalothorax with a white seam, and behind eye-region a white band.

One specimen from Tepic. Allied to *C. tæniola*.

**288. *Cyrene delecta* Peck.**—Several young specimens from Tepic.

**289. *Attus* sp.?**

Length 3.8 mm. (immature). Black, with white palpi, a pale band on the middle of the hind tibiae; coxae pale; basal band to abdomen, two oblique stripes on the anterior sides, the front one curving backward, the other obliquely forward, and side of cephalothorax narrowly white.

One specimen from Tepic.

**290. *Attus peninsulanus*, sp. nov.**

PLATE XVII, FIG. 16.

Length ♂ 4.6 mm.; ceph. 2.3 mm. long, 1.8 mm. broad. The cephalothorax yellowish, black on eye-region, a dark stripe on each posterior side margin, and rather darker in the middle behind; clypeus and mandibles light red-brown; legs pale, first pair infuscated; sternum pale. Abdomen pale, sides dark, a median black stripe above, wider near middle, then suddenly narrowed and deeply serrate behind; venter pale, usually with some dark dots; one specimen has the abdomen wholly infuscated. First row of eyes curved; S. E. fully one-half the size of the M. E., and well separated from them. Cephalothorax moderately high, rather highest at dorsal eyes; eye-region equally wide in front and behind. First pair of legs longest; first coxae separated by full width of lip; fourth metatarsi spined to base. Tibia of ♂ palpus has a tooth on inner side at base and a long projection at tip on outside. An immature ♀ is like the ♂, but first pair of legs paler.

Several specimens; Sierra San Lazaro, Sept., and two from La Chuparosa.

**291. *Euophrys obscurus*, sp. nov.**

PLATE XVII, FIG. 14.

Length 6 mm.; ceph. 2.4 mm. long, broad 1.8 mm. Cephalothorax red-brown, darker on eye-region, a pale stripe each side from dorsal eye back to the hind margin; clypeus dark, with pale hair; palpi banded; mandibles pale; legs pale, with dark rings at tips of femora and patellæ, and bases and tips of tibiæ and metatarsi; sternum pale. Abdomen brown above and on the sides, some indistinct pale spots and two larger marks just before the spinnerets; venter paler, with dark dots. Cephalothorax rather low and flat. Abdomen somewhat depressed. Third leg a little shorter than fourth; fourth metatarsi spined to base. S. E. more than one-half as large as M. E.; third row almost as wide as cephalothorax at that point.

Several female specimens from Coral de Piedras and La Chuparosa.

**292. *Habrocestum cæcatum* Hentz.?**—One pair (the male immature) from Tepic appear to belong to this species.

**293. *Habrocestum conjunctus*, sp. nov.**

PLATE XVII, FIG. 8.

Length ♂ 4.5 mm.; ceph. 2.4 mm. long, broad 1.8 mm. The cephalothorax is pale; eye-region black, red hairs above first eye-row and on eye-region; clypeus pale, a black stripe each side extends back from dorsal eyes toward the hind margin, the side margins white, a long median black triangle behind; mandibles pale; palpi pale; sternum margined with black. Legs pale, a crest of white hair on femur, patella, and tibia I, black beneath on tibia I, hind pairs with tips of joints darker. Abdomen pale, a long black stripe each side, connected at tip, a dark spot at base between them, sometimes wholly dark at base, sides black; venter with three indistinct dark spots. Third pair of legs much the longest; patella simple. The ♀ is 6 mm. long. Cephalothorax red-brown, darkest on eye-region. Abdomen brown above, with oblique white stripes each side, two spots in the middle and some chevrons behind; venter with three indistinct dark lines. Legs pale; sternum margined with black.

A few examples from San José del Cabo and Magdalena Island.

**294. *Habrocestum divaricatum*, sp. nov.**

PLATE XVII, FIG. 7.

Length ♂ 5 mm.; ceph. 2.5 mm. long, broad 1.8 mm. The cephalothorax is pale; eye-region and clypeus black, a white spot under each lateral eye, a median black triangle from posterior margin, and each posterior side narrowly black; mandibles black; palpi black, some white hair on the patellæ; legs pale, anterior femora infuscated, posterior pairs banded, dark lines on the tibiæ; sternum pale; abdomen pale, two dark stripes above, connected near spinnerets, not reaching front margin; venter black on basal part and on sides, pale behind, with a median black T mark. Third pair of legs much the longest; patella prolonged above in a reddish point. What I take to be the ♀ is paler than the ♂, the cephalothorax, however, marked the same. Legs all pale; abdomen light brownish, with oblique pale stripes each side and a median one in posterior part; venter with three dark lines; it is 6 mm. long.

Several specimens from Sierra San Lazaro, Sept.

**295. *Habrocestum aztecanum*, sp. nov.**

PLATE XVII, FIG. 9.

Length ♂ 5 mm. Cephalothorax pale; eye-region dark, crossed by fine white band in front, dorsal eyes on black spots, below them a white spot; eyes of second row surrounded by white, a long median triangular black spot behind, and an oblong spot each side; clypeus white haired; legs pale, striped with black except tarsi; the mandibles white, with a long black spot each side at base; sternum and coxæ wholly pale; abdomen with two large dark spots at base, and behind a large triangular black spot enclosing a small white triangle, sides black; venter with a black median stripe. Usual structure of the genus; patella of leg III enlarged and prolonged above; one spine above on tibia III, two above on metatarsus III. A ♀, possibly of this species, is 6 mm. long, and looks much like *H. cristatum* Hentz. It has dark cephalothorax, with white hair on sides, and indistinct marks on the brown abdomen.

A few specimens from Tepic, Nov.

**296. *Habrocestum dorsalis*, sp. nov.**

PLATE XVII, FIG. 12.

Length ♂ 5 mm.; ceph. 2.5 mm. long, broad 1.7 mm. Cephalothorax dark brown, scarcely darker in the eye-region, clothed with white scales and long black bristles, clypeus dark; mandibles red-brown; palpi, sternum, and legs dirty yellowish, with some white scales and long hairs; abdomen brown, paler beneath, with white scales and long hairs, a narrow white median stripe from base to apex, its posterior part broken into spots, some small spots on the

sides. Cephalothorax longer than usual; posterior eye-row as broad as the anterior row. Third pair of legs plainly longer than the fourth; patella III simple.

One male; Hermosillo.

**297. *Habrocestum cinctipes*, sp. nov.**

PLATE XVII, FIG. 11.

Length ♀ 6 mm.; ceph. 2.3 mm. long, broad 1.7 mm. Cephalothorax dark red-brown, clothed with white hairs and black bristles, latter very numerous in the eye-region; clypeus dark, with long white hair on the margin; palpi pale, yellow-haired; anterior pair of legs dark, pale at bases of patellæ, tibiæ, and metatarsi, other pairs pale, all joints dark at bases and tips; sternum dark; abdomen light gray, a large long brown stripe above with projections on its sides and containing some pale chevrons behind; sides and venter light gray. Cephalothorax rather slender. Abdomen high and convex, pointed behind, truncate at base.

One specimen from Sierra San Lazaro, Sept. It is separated from the other species by its banded legs and by the narrowness of the abdominal markings.

**298. *Habrocestum dubitatum*, sp. nov.**

PLATE XVII, FIG. 10.

Length ♀ 7 mm.; ceph. 2.9 mm. long, broad 2 mm. Cephalothorax red-brown, obscure, darker in the eye-region, clothed with whitish hair and blackish bristles; clypeus white, with long white hair; mandibles black; palpi and legs and sternum pale; abdomen pale on sides and below, above mostly brownish, with a median white stripe behind and two side spots.

One example; San José del Cabo.

**299. *Habrocestum*, sp.?**—Two small specimens (females) apparently of different species; one from Hermosillo, with pale legs; it cannot be the female of *H. dorsalis*, as it has a much broader cephalothorax and looks quite different. The other with dark legs is from Orizaba. Both are obscurely marked and unknown to me and are better not described.

**300. *Zygoballus parvus* Hentz.**—A few female specimens from Tepic.

## PSEUDOSCORPIONIDÆ.

301. *Chelanops*, sp.?—One specimen probably new. It has simple hairs and is related to *C. oblongus*, but has pale palpi. Hermosillo.

302. *Ideoroncus mexicanus*, sp. nov.

Length 2.4 mm. Cephalothorax once and one-half longer than broad, a little broader behind than in front; one eye each side; mandibles of moderate size, a hair-like stylet. Palpi quite long, trochanter swollen behind; femur rather longer than cephalothorax, nearly cylindrical; tibia one-fourth shorter, short pedicellate, but little swollen either side and no broader than femur; hand evenly convex outside, very strongly so on inner margin, being at one place twice as broad as femur; fingers slender, longer than hand, slightly curved; body narrow, widest in the middle; segments undivided.

One specimen; San Miguel de Horcasitas. Differs from *I. obscurus* in smaller size, more slender tibia, and much longer fingers.

303. *Chelifer scabrisculus* Sim.—One example; Sonora.

## PEDIPALPI.

304. *Buthus carolinianus* Beauv.—A few specimens without locality, probably from eastern Mexico.

305. *Thelyphonus giganteus* Latr.—A few from Mexico, without farther locality.

306. *Admetus asperatipes* Wood.—Many examples from San José del Cabo and Sierra San Lazaro, March and Sept.

307. *Admetus coronatus* Butler.—Two from Mazatlan, Nov.

## SOLPUGIDA.

308. *Datames formidabilis* Sim.—A number of specimens of this large species from San José del Cabo and Sierra San Lazaro, Sept.



**309. *Datames putnamii*, sp. nov.**

PLATE XVII, FIG. 29.

Length ♂ 22-24 mm. (exclusive of mandibles); mandibles 5 mm. long; upper finger 5.5 mm. long; head 6 mm. broad; tibia of palpus 7.5 mm. long. Head and mandibles reddish yellow, former margined with black in front, fang red-brown; abdomen above dull blackish or purplish, hardly darker in the middle, paler beneath; legs and palpi pale yellowish, tips of latter scarcely darker. Head broader than long, straight in front; eyes separated by nearly their diameter; mandibles of the usual shape, upper finger unarmed, lower with a large tooth toward the base, and a small one just beyond; between the two fingers, on the fond of the jaw, there are two rows of three teeth each, and above these two little denticles. Legs and palpi moderately hairy and spined as usual; there are no small conical spines on the metatarsi of palpi, but long spines on the tibiae; on the middle of the hind margin of the fourth ventral segment there are four short stiff spine-like appendages (not in ♀). Aside from sexual differences, the ♀ is similar to the male, except larger.

Several specimens from Sierra San Lazaro, Sept., and San José del Cabo, Oct. This species differs from *D. girardii* in pale legs, head, and mandibles, in lacking a tubercle at the base above on upper finger of mandible, and in lacking conical spines on the metatarsus of palpus; the armature of the mandibles is, however, nearly the same, but the small teeth on the lower finger are almost invisible, the tip of this finger is not so curved, nor is it indented below as in *D. girardii*.

**310. *Datames*, sp.?**—One pair from San José del Cabo appear to belong to a different species than *D. formidabilis*, although quite similar; yet additional material would, I think, be necessary to decide the question.

**311. *Cleobis peninsulanus*, sp. nov.**

PLATE XVII, FIG. 30.

Length 14 mm.; head 3.8 mm. long, broad 4.2 mm.; mandibles 4.2 mm. long (including upper finger); tibia of palpus 5 mm. long. Cephalothorax and mandibles yellowish, the tips of the fingers red-brown; legs and palpi pale yellowish, the palpi with tibia (except at extreme base and tip) reddish brown, and the metatarsi and tarsi entirely reddish brown; abdomen light

gray, with a darker light chocolate brown stripe, most distinct on the margins and on the median line. Head broader than long, anterior margin retreating each side from the eyes, which are fully their diameter apart, median groove plain, only short hairs on the head. Mandibles long and stout, with bristles of moderate length; both fingers much curved at the tip, the upper one with several small teeth, the lower with two larger teeth and a small one between them; on the upper finger above, near base, is an elongate elevation or ridge. Palpus clothed with short fine hair, the tibia plainly enlarged before tip; legs as usual, with short hairs and bristles; the triangular piece at base of venter shows a narrow median groove on its posterior half.

Several specimens from San José del Cabo, and one from Hermosillo.

### 312. *Cleobis hirsuta*, sp. nov.

PLATE XVII, FIG. 31.

Length 11 mm.; head 2.7 mm. long, broad 2.8 mm.; mandibles (including finger) 3 mm. long; tibia of palpus 5 mm. long. Cephalothorax pale yellowish, rather reddish on the sides, leaving a pale central diamond-shaped figure; eyes on black spots; mandibles pale yellowish, a paler stripe above, fingers reddish at tips; palpi rather yellow brownish on all except the basal joint. Legs and abdomen pale, the latter with a median light brown stripe above. Head about as broad as long, the front margin recedes each side from the eyes, the latter much more than their diameter apart, the median groove distinct. Mandibles longer than head; fingers short, the upper one is emarginate above and also externally, below with two small teeth and some minute denticles toward the base; the lower finger has two rather large teeth; both of the fingers strongly curved at tip. The palpi, legs, and abdomen are as usual; the body is more hairy than usual, and on the appendages the hairs are extremely long, giving the creature a somewhat hoary appearance.

One specimen from San Miguel de Horcasitas. Readily known by the curious shape of the upper finger of the mandibles and the long hair.

## ACARINA.

### 313. *Trombidium peninsulanus*, sp. nov.

Length 3.5 mm. Red; body somewhat pyriform, flat above, broadest in front, concave each side near middle, slightly concave in front, broadly rounded or even a little emarginate behind with several pairs of round impressions above. Body clothed above with short dense erect nearly clavate

hairs, appressed and not clavate on legs and venter. Legs very short, fourth pair longest, scarcely as long as body; last joint of leg I just about equal to penultimate; palpi short; second joint swollen above, clothed with long hair; third a little longer than broad; fourth short, tipped with a stout claw; thumb longer than claw, slender, scarcely clavate, and nearly bare.

Several from La Chuparosa and Sierra San Nicolas, Sept.

**314. *Rhyncolophus echinatus*, sp. nov.**

Length 3.2 mm.; broad 2.3 mm. General color dull blackish. Body short, broadly rounded in front and behind; dorsal groove enlarged in the middle, does not reach middle of dorsum; two eyes each side, frontal tubercle slender capitate. Legs thick and short, not as long as body is broad; broad and dense scopulas under all tarsi; palpi very small and slender, pale colored. Body and legs clothed above with many black, appressed, curved, short, stiff, pointed, roughened bristles or spines, above on the body are some black, scattered, erect, longer, clavate, roughened bristles, beneath the bristles are smaller.

One example from San José del Cabo.

**315. *Rhyncolophus pedatus*, sp. nov.**

Length 2-2.8 mm.; tibia IV 3.5 mm. Wholly pale yellowish. Body short and broad, broadly rounded behind, dorsal groove short, enlarged at end, not reaching to end of first third of dorsum; two eyes each side; mouth-parts short, rapidly tapering, seen from side there is a short tubercle above; palpi of moderate size, the femora enlarged toward tip, the tibia smaller, about half as long, the claw about as long as the thumb. The body bears above scattered short stiff, nearly erect bristles that are as large at tip as elsewhere and slightly roughened. The legs are extremely long and slender; the tarsi swollen and furnished with scopulas; the other joints have many stiff serrate spine-like hairs; the venter is clothed with many fine hairs.

Three specimens; Hermosillo.

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<i>parva</i> . . . . .	264	<i>rufipes</i> . . . . .	236
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<i>Thanatus peninsulanus</i> . . . . .	265	<i>ZILLA californica</i> . . . . .	255
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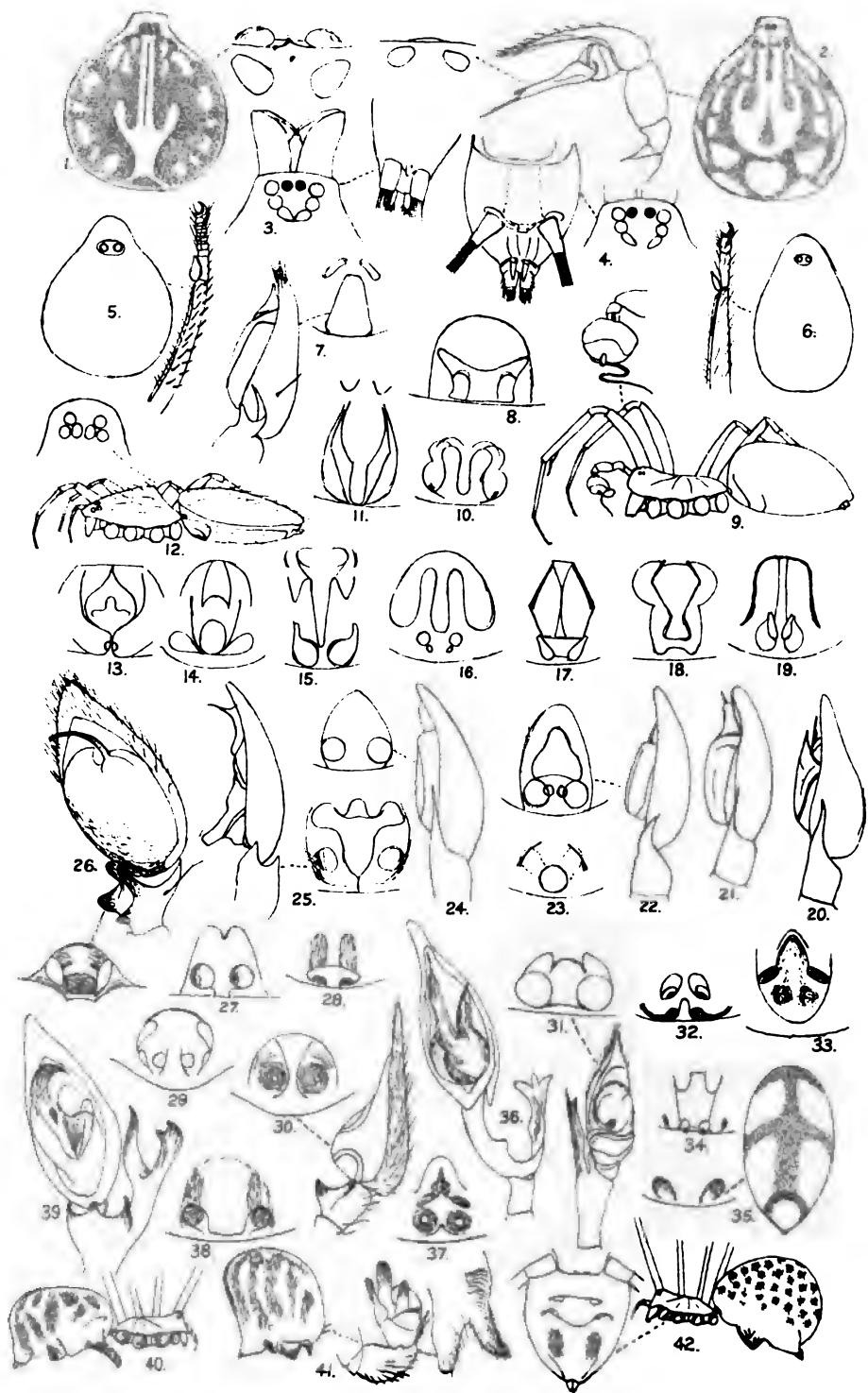




## EXPLANATION OF PLATE XIII.

(All new species.)

- Fig. 1. *Scytodes mexicanus*.  
2. " *perfecta*.  
3. *Zimiris pubescens*.  
4. " *griseus*.  
5. *Nops sternalis*.  
6. " *ovalis*.  
7. *Drassodes perditus*.  
8. *Drassus singularis*.  
9. *Plectreuryx bicolor*.  
10. *Leptodrassus incertus*.  
11. *Drassus orizaba*.  
12. *Gamasomorpha rufa*.  
13. *Gnaphosa distincta*.  
14. " *decepta*.  
15. " *abnormis*.  
16. *Prothesima peninsulana*.  
17. " *gentilis*.  
18. " *mexicana*.  
19. " *fidelis*.  
20. " *indecisa*.  
21. " *directa*.  
22. " *completa*.  
23. *Cesonia trivittata*.  
24. " *mexicana*.  
25. *Megamyrmeleon californicum*.  
26. *Corinna peninsulana*.  
27. *Trachela mexicana*.  
28. " *parvulus*.  
29. *Thargalia gracilis*.  
30. " *dorsata*.  
31. *Anyphaena futilis*.  
32. *Gayenna minuta*.  
33. *Prothesima grisea*.  
34. *Gayenna ignava*.  
35. *Thargalia venusta*.  
36. *Chiracanthium parvulum*.  
37. *Gayenna orizaba*.  
38. *Thargalia mexicana*.  
39. *Clubiona complicata*.  
40. *Physocylus mexicanus*.  
41. " *cornutus*.  
42. *Psilochorus minutus*.







## EXPLANATION OF PLATE XIV.

(New species except Figs. 7 and 8.)

- Fig. 1. *Lithyphantes parvula*.  
2.       "       *venusta*.  
3.       "       *medialis*.  
4.       "       *punctulata*.  
5.       "       *transversus*.  
6.       "       *autumnalis*.  
7.       "       *pulcher*.  
8.       "       *pulcher*, var.  
9. *Linyphia dorsalis*.  
10.       "       *eiseni*.  
11. *Theridium confraternus*.  
12. *Acartauchenius insanus*.  
13. *Chrysso splendida*.  
14. *Bathyphantes transversus*.  
15. *Ceratinopsis rosea*.  
16. *Grammonota nigriceps*.  
17. *Bathyphantes tragica*.  
18. *Pocobletus mexicanus*.  
19. *Dictyna avara*.  
20. *Altella polita*.  
21. *Tegenaria modesta*.  
22. *Agalena peninsulana*.  
23. *Amaurobius peninsulanus*.  
24. *Grammonota gentilis*.  
25. *Dictyna miniata*.  
26. *Tegenaria obscura*.  
27. *Cœlotes exaptus*.  
28. *Tmeticus incertus*.  
29.       "       *denticulatus*.  
30. *Agalena orizaba*.  
31. *Uloborus formosus*.  
32. *Trachelas speciosa*.







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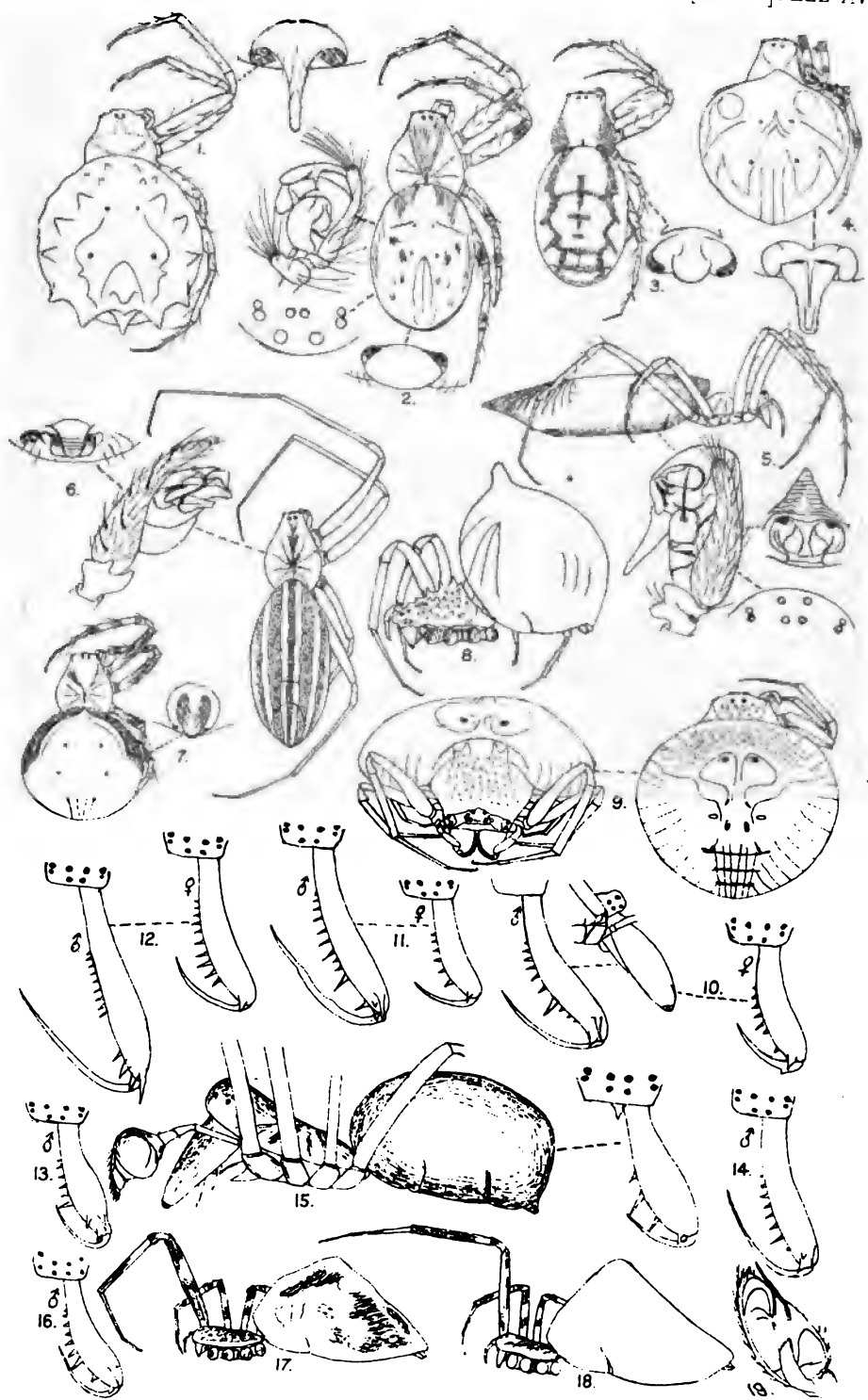
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## EXPLANATION OF PLATE XV.

(New species, except Fig. 7.)

- Fig. 1. *Epeira perplexa*.  
2. " *zilloides*.  
3. *Singa moesta*.  
4. *Epeira singularis*.  
5. " *caudata*.  
6. *Larinia bellona*.  
7. *Epeira detrimentosa*.  
8. *Ordgarius corpulentus*.  
9. " *obesus*.  
10. *Tetragnatha convexa*.  
11. " *fraterna*.  
12. " *peninsulana*.  
13. " *atriceps*.  
14. " *intermedia*.  
15. *Glenognatha minuta*.  
16. *Eugnatha orizaba*.  
17. *Uloborus diversus*.  
18. " *albineus*.  
19. *Azilia mexicana*.







## EXPLANATION OF PLATE XVI.

(All new species.)

- Fig. 1. *Misumena modesta*.  
2. " *fidelis*.  
3. " *peninsulana*.  
4. " *consueta*.  
5. *Xysticus fissilis*.  
6. " *orizaba*.  
7. " *apertus*.  
8. " *curtus*.  
9. *Ebo mexicana*.  
10. *Tmarsus separatus*.  
11. *Thanatus peninsulanus*.  
12. *Misumena conferta*.  
13. " *decora*.  
14. *Selenops debilis*.  
15. *Olios luctuosa*.  
16. *Selenops morosa*.  
17. *Hypsinotus testaceus*.  
18. " *mexicanus*.  
19. *Olios peninsulanus*.  
20. *Pardosa sierra*.  
21. " *bellona*.  
22. " *peninsulana*.  
23. " *futilis*.  
24. " *dilecta*.  
25. *Lycosa concolor*.  
26. " *punctiventris*.  
27. *Pardosa parallela*.  
28. " *sabulosa*.  
29. " *medialis*.  
30. *Lycosa emuncta*.  
31. " *adusta*.  
32. " *futilis*.









## EXPLANATION OF PLATE XVII.

(New species except Figs. 23 and 25.)

- Fig. 1. *Lycosa injusta*.  
2.     "     *persimilis*.  
3.     "     *mexicana*.  
4. *Trochosa mexicana*.  
5. *Dolomedes major*.  
6.     "     *minor*.  
7. *Habrocestum divaricatum*.  
8.     "     *conjunctus*.  
9.     "     *aztecanum*.  
10.    "     *dubitatum*.  
11.    "     *cinctipes*.  
12.    "     *dorsalis*.  
13. *Philæus consimilis*.  
14. *Euophrys obscurus*.  
15. *Pachomius niger*.  
16. *Attus peninsulanus*.  
17. *Philæus limbatus*.  
18.     "     *trimaculatus*.  
19. *Helorus perditus*.  
20. *Phidippus nigripilosus*.  
21.    "     *disjunctus*.  
22.    "     *funebis*.  
23.    "     *georgii*.  
24.    "     *fraternus*.  
25. *Dynamius opimus*.  
26. *Oxyopes brevis*.  
27.    "     *acuta*.  
28.    "     *flava*.  
29. *Datames putnamii*.  
30. *Cleobis peninsulana*.  
31.    "     *hirsuta*.





PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES.

THIRD SERIES.

ZOOLOGY.

VOL. I, No. 8.

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The  
Anatomy of Chelyosoma Productum  
Stimpson.

BY

FRANK WATTS BANCROFT.

WITH ONE PLATE.

*Issued October 5, 1898..*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1898.



# THE ANATOMY OF CHELYOSOMA PRODUCTUM STIMPSON.

BY FRANK WATTS BANCROFT.

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## INTRODUCTION.

PART of the material which formed the basis of this study was derived from the collections of the University of California, and the remainder from a very interesting lot of Puget Sound ascidians which the Young Naturalist's Club of Seattle sent to the University for examination. The specimens were mostly alcoholic, but a few were fixed in picrosulphuric or glacial acetic acid.

The investigation was carried on under the direction of Professor William E. Ritter, for whose constant kindness, not only in connection with my research, but in many other respects as well, I wish to express my most sincere appreciation.

The genus *Chelyosoma* was established by Broderip and Sowerby (1829) to accommodate the single species *C. macleayanum*, which, since then, has attracted considerable attention and has been examined quite frequently, especially by Danish and Scandinavian authors. In consequence of these investigations many anomalous characters



ascribed to it by the earlier writers have vanished, and its close relationship to *Corella* has been ascertained. But there are still several important points in its structure that remain to be elucidated. Kiaer (1893 and 1896) cites all the important literature dealing with the species. *C. productum*, the only other species<sup>1</sup> of the genus, was described by Stimpson (1864) from specimens collected at Puget Sound; and his very incomplete account was supplemented in 1884 by Drasche's (1884) excellent description of a few individuals from the same locality. So far as I know this species has not been described since that time.

#### RANGE AND EXTERNAL APPEARANCE.

*C. productum* undoubtedly occurs all along the Pacific coast of the United States and probably also of British Columbia. The center of its range seems to be in the vicinity of Puget Sound, for the specimens from there are quite numerous and surpass in size any that I have met with in California. In the latter state it has been collected from Point Mendocino in the north to San Pedro in the south, but is nowhere abundant. A few specimens were found on the under sides of rocks, some were obtained by dredging in shallow water, and a few from 80 or 90 fathoms.

The color in the younger individuals is whitish, the test being transparent so that the internal organs can be seen through it. In most of the older individuals, however, the surface is conspicuously coated with an opaque yellow or brownish layer which will be considered more in detail later. Some individuals have the base of the test wrinkled and discolored, while the remaining portion is thin and quite clear.

The shape is very characteristic, in spite of considerable variation, dependent largely upon the age of the individual (figs. 1, 2, 2a). The most striking external feature is the oval disk which is divided into the movable plates that have

<sup>1</sup> Neither Stimpson's (1852) description of *Ascidia geometrica* nor the figure published by Verrill (1874) show that the individuals they examined differ in the least from *C. macleayannum*.

given the name to the genus. It is invariably present, and is anteriorly and dorsally situated, making an angle of about 45 degrees with the main axis. Its plane is not, however, perpendicular to the sagittal plane, but slopes a little towards the left. This slope is correlated with a greater development of the muscles on the left side. In life the surface of the disk is usually plane or convex; the concavity seen in the figures is the result of contraction. The youngest individuals collected (disk 7 to 9 mm. long) are much depressed and attached by a broad base which is parallel to the disk; in fact their shape is much like that of *C. macleayanum*. Of the medium sized individuals (disk 9 to 20 mm. long), one with this depressed shape was found, but the majority present what appears to be the distinctive shape of the species (figs. 2, 2a). Here the region posterior to the disk is largely developed, raising the shield behind; and a low ridge is noticed passing from the right posterior portion of the disk diagonally around the posterior part of the animal and down to the left hind corner of the broad base. A few of the larger individuals (disk 25 to 30 mm. long) still retain something of this shape; but most of them have assumed an elongated or clavate form with the attachment at the smaller end and the disk placed obliquely on the free extremity (fig. 1). Most of the low ridge is obliterated, but the anterior part persists and is often sharply compressed, thus forming the "carina" mentioned by Stimpson. The largest individual examined measured 65 millimetres in length, 38 in width (dorsoventral), and 25 in thickness; the disk was 40 by 26 millimetres. The dimensions of an average Puget Sound specimen were: length 45, width 26, thickness 21, and disk 32 by 20 millimetres. All the California individuals were much smaller, the largest having a disk 18 millimetres long.

#### THE DISK.

According to Stimpson and Drasche the disk is divided into fourteen plates, but in the twenty-three individuals I

have examined the number is by no means constant. The number of plates, exclusive of those composing the siphons, varied from thirteen to twenty, the different numbers being distributed as follows:

No. of Plates in Disk.	No. of Individuals.
13	2
14	5
15	5
16	2
17	4
18	2
19	2
20	1
15.87	= Average.

But the variation is more than these figures indicate, for, in the groups having the same number of plates in the disk, the arrangement of the plates varied so much that in no case more than three individuals were encountered whose disks were alike in all respects.

There are in all disks three well defined classes of plates:

(1) The *siphonal* plates, which surround the orifices and form the covering of the conical siphon. They are quite constantly six to an orifice. In 24 individuals all had six surrounding the branchial orifice, while one atrial siphon had seven and another five plates. The branchial siphon is almost invariably placed nearer the end of the disk than the atrial, it is usually the longer and the area of its base of attachment is less. Its apex, however, is usually less acute and the plates do not fit so well as in the atrial siphon on account of the greater development of the layer of test on the inside of the siphon.

(2) The *central* plates (*c*, fig. 3), which are placed between the two siphons and are usually two in number. A single one such as occurs in *C. macleayanum* has never been met with; but twice three central plates were encountered, a small median one having been interposed between the other two.

(3) The *peripheral* plates, situated around the edge of the disk. They vary greatly in number, and exhibit bilateral symmetry in about half the individuals examined. In the asymmetrical disks there is a tendency for the number of plates on the right side to be increased. Ten cases of this variation and but three of the opposite one were observed. Figure 3 illustrates a case of this asymmetry. Among the peripheral plates one may distinguish *lateral* ones, the inner ends of which abut, at least partially, against the central plates, and *anterior* and *posterior* ones whose inner ends reach only the siphonal plates. The lateral plates are usually four in number, but occasionally, as in fig. 3, additional ones are found. In some of the lateral plates the corner which is next to the siphon becomes extended (\* fig. 3), and occasionally, especially in the broader disks, it is found entirely separated and forming a little accessory quadrilateral plate. The anterior plates are smaller and usually more numerous than the posterior ones. Occasionally the number of peripheral plates is increased by the interposition of small triangular plates which reach neither to the central nor siphonal ones.

Every plate of the larger individuals has its central portion considerably thicker than the periphery (fig. 4), and this change in thickness being quite abrupt is indicated in surface views by a faint line within and parallel to the boundary of the plate. In extreme cases several concentric series of these lines are present. On the other hand, the youngest individuals examined had plates which were of uniform thickness and hence exhibited none of these lines.

#### UNION OF THE PLATES.

Wagner (1885), who evidently examined the living animals, gives the only correct account of the relations existing between adjacent plates. He says: "Die Ränder der dieses Integument zusammen setzenden Platten erscheinen ziemlich biegsam und weich, wodurch dasselbe an diesen Stellen je nach dem Willen des Thieres ausgedehnt oder verengt werden kann." Sections through this region show

that the cause of the flexibility is a local thinning of the test and a more fibrous structure of its matrix (*h*, *h'*, fig. 4). As the change in thickness is always abrupt a very well defined hinge is thus formed. In the contracted condition shown in the figure the hinge appears at the bottom of a groove which is of a narrow V-shape in the younger individuals. In the older ascidians the width increases greatly, so that the cross-section, in the contracted condition, shows the hinge bent nearly double and projecting below the ventral surface of the test. An early stage in this widening of the groove and hinge is shown at *h*, fig. 4. In this condition the approximation of the edges of the groove and the foreign matter that accumulates in it make the boundaries of the plates quite conspicuous. When on the other hand the muscles of the animal relax, the elastic hinges straighten out, the grooves in which they were located become broader and shallower, and the outlines of the plates are consequently much less distinct. The line that bounds the plates peripherally (*p*, fig. 3) has not the same character as the hinges, but merely represents an irregular local thinning and wrinkling of the test.

#### THE TEST MATRIX.

The consistency of the test is cartilaginous, but, in the disk especially, it is somewhat brittle, cracking when bent much.<sup>1</sup> The matrix is composed of two very distinct layers; an inner, of animal cellulose or tunicin, and an outer one which is not composed of this substance and is much thinner (fig. 4).

The tunicin layer is translucent or transparent. Its matrix is for the most part homogeneous, but fibres are quite plentiful in certain rather variable regions. They always occur quite abundantly in thinnest parts of the test, especially the hinges, and are sporadically encountered in other places. In the disk their direction is parallel to the surface, but in the other parts of the test quite a few

<sup>1</sup> It has been said so often that the test of *C. macleayanum* is horny that one would be tempted to consider the two species quite different in this respect were it not for the description of Swederus (1887) which states that the test is leathery.

prominent fibres are seen running at right angles to the surface.

The outer layer, which corresponds to the yellow external layer of Löwig and Kölliker (1846), Schulze (1862), and Hertwig (1872), is, as they state, different from cellulose. Towards reagents it behaves like the substance examined by Schulze, giving no blue color with Potassium Iodide and Sulphuric Acid, and being insoluble in concentrated Sulphuric Acid. Boiling with dilute alkali does not dissolve it, but hot concentrated Potassium Hydrate dissolves or at any rate disintegrates the layer. It is slightly harder, stiffer, and more brittle than the tunicin layer, but is formed from it as the sequel will show. In sections it takes a deeper stain than the cellulose, is much more highly refractile, and usually appears homogeneous, but sometimes is differentiated into layers (fig. 5). In some places, however, where it does not seem to be fully formed, it has a more granular appearance. It covers the whole surface of the ascidian, being thinnest on the hinges, a little thicker than the average on the disk, and thickest at the edges of the orifices. It does not cover the surface of the test that extends into the siphons. In addition to covering the surface it is also found within the test in the region of the siphonal ridges which project inwards from the median line of each siphonal plate; but here it occurs in its less compact granular form. As the most powerful muscles of the body are attached to these ridges they must be quite strong; and it seems that the extra supply of yellow substance is introduced to add rigidity to the structure. On the contrary, where flexibility is required, as in the hinge, the thickness of the yellow surface layer is reduced to a minimum and additional fibres added to the tunicin layer.

#### CELLS IN THE TEST.

All the functionally active cells in the test appear to be of mesodermic origin. In rare cases I have found cells that have been derived from the ectoderm. They have

the size and shape of the columnar ectoderm cells, and are found in their best state of preservation in the inner layers of the test, but I have been unable to find a distinct nucleus in any of them. The best occurrence of these cells is shown on the right in fig. 6, and the absence of distinct nuclei is apparent. It must be said, however, that in some places (fig. 10) the nuclei of ectoderm cells that are certainly functionally active have not been differentiated. The distinct nuclei in the proximity of these scattered cells belong to mesodermic cells which may be exercising their phagocytic function. It seems then that ectoderm cells are at times accidentally imbedded in the test, but when there they are no longer able to secrete cellulose and gradually degenerate.

Most of the mesodermic cells are bladder cells. Occasionally, in the innermost layers of the test exceptions are met with in the shape of cells with an abundant granular cytoplasm which entirely fills the cavity of the test they are located in (fig. 7). These, however, are comparatively rare, and as they pass into the outer layers of the test become vacuolated and transformed into typical bladder cells. The latter (figs. 6, 7, 8, 9) are much smaller than the bladder cells in those species of *Ascidia* where they are so greatly developed, and occupy a much smaller proportion of the test. They always present a deeply stained nucleus, but sometimes the cytoplasm and the test cavity which contains it are difficult to make out. The size of the nuclei is quite variable, ranging from that of the ectoderm nuclei to minute, deeply staining bodies one-half or one-third of a micron in diameter. These smaller nuclei seem on the whole to be more frequent in the outer layers. When prepared with most stains the cytoplasm does not seem to extend beyond the wall of the bladder; but a very deep stain, or better still, treatment with Potassium Iodide and Sulphuric Acid brings out quite a number of straight, slender, cytoplasmic processes extending into the test matrix (fig. 8). The size of the cells is much smaller in the densely fibrous parts of the test, and their shape is fusiform

instead of oval as in the other parts. If, however, the matrix is homogeneous, the bladder cells nearest to the ectoderm are just as large as those in the center and differ from them only in having in some cases a slightly larger amount of cytoplasm. We see then that as these cells come to lie in the outer layers of the test the cytoplasmic and nuclear material diminishes and the test cavity remains the same.

#### ORIGIN OF THE YELLOW LAYER.

It has been said that the outer yellow layer of the test is formed by the activity of the cells in the tunicin layer. The steps in the process can be followed quite easily, but unfortunately the principal criterion that must be used in following out the stages cannot be well represented in the drawings. This is the characteristic appearance of the yellow substance due to its homogeneous structure and high index of refraction. In some regions, especially in the siphonal ridges, it is found in a granular, more lightly colored form, thus losing some of its characteristic appearance; but it retains its high refractility and grades insensibly into the more compact form so that there can be no doubt of its identity. The first step in the formation of the yellow substance is the deposition of a thin layer of it in the vicinity of the wall of a bladder cell. The deposit may be of the compact or granular form, and either just within or without the wall of the bladder. Figure 9, *a*, shows a cell with a thin layer of the substance just inside the bladder, *c*, a cell with the substance deposited on the outside only. Figure 9, *b*, represents a stage in which the deposit has been principally within, as shown by the angular vesicle. The size of the deposit about many of the cells, such as *c*, fig. 9, and *a*, *b* and *c*, fig. 5, shows that most of it has been laid down on the outside of the bladder. Appearances like *a* and *b*, fig. 5, where isolated masses surrounding individual cells fuse with the outer layer, are very numerous and the fusion is always perfect, no line of contact being visible at all. This together with the identical



appearance of the substance surrounding the cell and that composing the yellow layer shows conclusively the way in which the latter is formed. It does not, however, grow exclusively by incorporating masses that were originally separate, for some cells do not take on this function until they are closely pressed against the outer layer, so that from the first the product of their activity is in contact with this layer. In some cases, especially in the siphonal ridges, a number of cells do not seem to begin forming the yellow substance until they have been nearly or quite surrounded by it. The ultimate fate of the cells in the yellow layer seems to be degeneration, for of those nearest the surface nothing can be seen but a small vesicle containing some refractile material in which usually not even the remains of a nucleus can be made out. As there are extensive regions of the test which contain no blood-vessels at all, the bladder cells must be in great measure physiologically isolated from the rest of the body, for they could receive nutritive fluids only by way of the rather dense cellulose substance. On this account I think it likely that the yellow substance is formed almost entirely by a direct transformation of the cellulose, and accordingly it would be interesting to know the exact chemical relations between the two substances.

#### BLOOD-VESSELS IN THE TEST.

These are usually confined to the posterior region near the base of attachment, at times extending half way up the free wall towards the disk; but they have never been found extending into the disk. The proximal part of the system is composed of a large number of pairs of vessels running side by side, as in *Ascidia* and other tunicates, but the terminal part in which these two vessels communicate with each other is very greatly developed. It is much more capacious and consists of large single or compound and irregularly branching ampullæ, present in such numbers that the substance of the test is fairly honeycombed in

places. Nor are these ampullæ confined to the terminations of the blood-vessels, for one or even several pairs of blood-vessels may enter the cavity from a proximal direction and another pair leave it distally to unite again in some terminal ampulla.

#### UNION OF MUSCLES AND TEST.

Both Eschricht (1842) and Drasche describe the intimate connection between the muscles and the test, especially in the region of the siphonal ridges; but so far as I know no one has described the means by which this union is accomplished. Wherever a bundle of muscle fibres is attached to the test the latter is produced into a conical or ridge-like papilla to the summit of which the muscles are joined. This attachment is accomplished principally through the intermediation of the ectoderm. The cells of this layer usually form a cubical or thin pavement epithelium which may become vacuolated and very irregular in places, but on the test papillæ the epithelium is always of the columnar form (figs. 6 and 11) and is more actively engaged in secreting cellulose. The increased activity in this region is proved by the presence of the test papilla which can hardly be explained except as the result of this activity, by the larger number and size of the ectoderm cells, and by the pronounced character of the processes that extend from them into the test. These processes have been found by Seeliger (1893, p. 494), Ritter (1893, p. 55), and others, who think that they are in some way connected with the active secretion of cellulose. In addition to subserving this function they insure a firmer union between the test and the ectoderm, but these two layers are nevertheless separated by the strong contractions of the animal. In fig. 10, *a* and *d*, this separation and the processes that have been torn out of the test are shown. In the adjacent sections of this series they are considerably more numerous, and the columnar cells more closely packed together. On the sum-

mits of the test papillæ the ectoderm instead of simply covering the papillæ forms convolutions and deep pockets (*pl*, fig. 11) which greatly increase the surface of contact and secretion. The muscle fibres seem to be attached to the ectoderm by means of the connective tissue lining this layer, and can be seen extending down into the ectodermal pockets. The whole contrivance renders the attachment of the muscles so firm that I have not seen a single case where they have been pulled away from the test.

It is probable that another result of these involutions is an occasional cutting off of the end of a pocket by a more rapid secretion near the mouth. The cells which were contained in the deeper portion would then become imbedded in the test matrix and give rise to the occasional ectoderm cells there that have already been described.

#### THE MUSCULATURE.

The fact that the distribution of the muscles in our species and *C. macleayanum* differs in one important respect has been clearly pointed out by Drasche. He divided the muscles of *C. productum* into four classes: (1) The peripheral muscles, situated around the edge of the disk and extending well towards the center (fig. 11). (2 and 3) The circular and longitudinal muscles of the siphons. (4) The twelve series of more or less fan-shaped muscles radiating from the siphons and attached to the outer ends of the siphonal ridges. In *C. macleayanum*, on the other hand, the peripheral system is much less developed and another system is added which is entirely lacking in all the individuals of the western species that I have examined. This is a system of short muscles joining adjacent plates in the extra-siphonal part of the disk. It appears to be the most fundamental type, for all the other classes are referable to it without difficulty. They all connect the plates with the test on the other side of a hinge-like thinner area, except some of the peripheral muscles of *C. productum*,

which extend clear across the peripheral plates and are united to the central ones.

In our species every muscle, except those connected with the siphons, is attached at some place on the disk, extends nearly to the edge of the disk and then bends ventrally and is attached to the side wall of the test some distance down. The inner fibres (the conspicuous ones in fig. 11) are the longest, being attached farthest from the edge of the disk and down the sides of the animal. Besides the inner fibres there are a lot of shorter ones (*m. s.*, fig. 11) that are attached nearer the edge of the disk at both ends. The musculature is much better developed on the left side, the fibres being longer and extending much farther down the side. There is a tendency for all of these muscles to be inserted near the centers of the plates, which are indicated by the heavy black lines in the figure. But the variation is so great that this tendency is hardly manifested at all in some regions. It is to be noted, however, that no muscles are ever inserted on the hinges.

In the siphons the radial muscles are weaker and situated internally to the circular ones. Centrally they are attached near the lip of the orifice, and thence extend beyond the region of the siphon, either losing themselves among the peripheral muscles or joining these directly. The circular ones consist of six series of strong fibres extending from one siphonal ridge to the next. A fair average condition of the fan-shaped muscles is seen in the figure. They join the outer ends of the siphonal ridges with the extra siphonal plates, and assist in closing the orifices both directly by their contraction, and indirectly by giving a more rigid support to the contracting circular muscles.

When we compare the two species of our genus, it is found that the arrangement and variability of the plates depend in great measure upon their relations with the muscles. In *C. macleayanum* the plates appear to be very constant in number and arrangement; for among the thirty-four or more individuals of which accounts have been

published the only indication of variation is in Swederus' description, where the number of plates is stated to be nine, instead of eight. Five figures of the disk have been printed and in all the plates are the same. Besides these there is one figure of Wagner's which would seem to indicate that the two anterior plates are wanting in that individual; the appearance, however, may be merely due to the perspective. The reason for this constancy lies in the fact that the muscles extend across all the hinges and are perpendicular to them. This is the most stable condition, and deviations of either muscles or hinge would cause no rearrangement, but would tend to be gradually obliterated by the interaction of the two. In accordance with this view we find that in *C. productum*, which is on the whole very variable, the siphons, in which the principal muscles cross the hinges at right angles, are remarkably constant. But on the other hand, the peripheral muscles are nearly parallel to the hinges of that region, and here we have the greatest variability. The conditions are unstable, for a slight deviation in the disposition of the muscles can easily cause a rearrangement. Thus, if in the large lateral plate *l*, fig. 3, a slight massing of the muscles at the two ends might have resulted in the formation of two plates there, just as has occurred on the opposite side. Similarly, the presence of one or more longitudinal hinges between the central plates, which is the most constant difference in the two disks, follows as a mechanical necessity from the arrangement of the muscles. Thus it becomes evident that all the differences in the disks of the two forms are correlated with the great development of the peripheral muscles in *C. productum*.

#### THE PHARYNGEAL APPARATUS.

The simple filiform tentacles are subject to considerable variation, which is independent of the size of the individual as the following measurements show:

Dimensions of Disk.	Number of Tentacles.
6 x 4	118
10.5 x 6	174
13 x 11.5	480
23 x 18	142
27 x 22	214
30 x 22	123

They are arranged in from two to four concentric rows, the largest ones being situated on the outer side, and the tentacles in adjacent rows alternating with each other in position. The tentacles are often considerably smaller and the rows fewer on the sides of the circle than anteriorly and posteriorly.

There is but one peripharyngeal band present, and since this connects with the edges of the endostyle and the epibranchial groove, it evidently corresponds to the outer of the two bands usually encountered. It is ciliated over its whole surface, and in some preparations appears to fuse with the lips of the dorsal tubercle. However, sections and the best dissections show that it extends posteriorly to the orifice of the tubercle to join the edge of the epibranchial groove.

Little remains to be added to Drasche's account of the relations of dorsal tubercle, hypophysial gland, epibranchial groove, and ganglion. His excellent figure of these organs represents a good average condition of my specimens, except that the ganglion usually has five nerves extending from it posteriorly, and that the hypophysial duct in all of the individuals I examined extends along the left edge of the gland, so that the tubules enter it from the right side only. The shape and positions of these organs is remarkably constant. They are all placed a little to the right of the median line joining the two orifices, exactly as in *C. macleayanum*<sup>1</sup>, and their relations to each other were always found to be exactly as in Drasche's figure.

<sup>1</sup> Drasche, who states that in this species the dorsal lamina is on the left of the median line, evidently does not understand Kachricht's figures.

The hypophysis is a compound tubular gland with eight or nine tubules emptying into the duct. On account of the thinness of the mantle in this region they are all in the same plane. Anteriorly a corner of the gland is ventral to the ganglion, but posteriorly it is at the same level or dorsal to the latter.

The ganglion usually has a pair of anterior nerves, a latero-anterior pair, and five irregularly arranged ones extending from its posterior end. Variations are, however, quite frequent.

#### THE BRANCHIAL SAC.

The branchial sac is attached to the mantle along the extent of the peripharyngeal band, epibranchial groove, endostyle, and postbranchial groove, and to the intestine along the whole of its terminal part, which is dorsal to the branchial sac. Many connectives extend to both mantle and viscera, but they have no very definite arrangement on account of the irregularity of the vessels.

The arrangement of the vessels is subject to considerable variation, a large part of which, however, depends upon the age of the individual. Figure 12 shows a portion of the branchial sac of the smallest individual collected. The conditions here are very regular and simple when compared with the older ones; but even in these a careful study shows essentially the same structure. There are four kinds of vessels: (1) The outer vessels (*o*, fig. 12), which occupy the outer surface of the sac and unite with all the connectives. They extend in longitudinal, transverse, and intermediate directions, and bound the spaces in which the spiral stigmata are contained. They are quite conspicuous, especially when seen from without, and contain most of the blood. (2) The spiral interstigmatic vessels, which, together with the outer ones surrounding them, limit the stigmata. In the younger individuals these are in a plane but slightly interior to the outer vessels, but later an increase in surface is effected by drawing the

spirals out into cones with their apices extending inwardly. At the same time the stigmata are often turned edgewise, so that in surface views their presence can hardly be detected. In these older individuals the edges of the outer vessels also grow beyond the edges of the stigmata, so that from the outside the latter cannot be seen, but only an irregular lot of spaces leading into the bases of the cones. In the figure it is seen that each spiral is composed of but one stigma, and that often the same stigma may be coiled at both ends and form two spirals. In the more mature condition there are two and occasionally three stigmata to a spiral, but never more nor less, so far as has been observed. (3) The intermediate vessels (*i*, fig. 12). They are very irregular, thin walled, and connect all the other vessels with each other in the most diverse ways. Receiving the blood that has reached the apex of the cone they distribute it to other vessels. One of their most important functions is to bear the connecting ducts which support the internal longitudinal bars. These ducts are often near the place of union of the intermediate vessels with the outer ones (*u*, fig. 12). Among the older individuals these vessels are much more strongly developed and sometimes almost completely mask the spiral vessels and stigmata. They form the most regular transverse vessels that the species possesses, usually, but not always, directly uniting adjacent connecting ducts. This regularity is most pronounced near the endostyle and dorsal lamina. (4) The internal longitudinal bars, which are never papillated. They are fairly regular over the whole surface of the branchial sac except where it is growing most rapidly, along the endostyle and dorsal lamina. In these regions all the stages in their formation from the smallest papillæ to larger ones whose anterior and posterior processes have just united can be seen. The connecting ducts invariably curve so that their inner ends point dorsally, and in the larger ascidians they are often so crowded as to be two or three times as numerous as those in the figure.



As a result of all these processes, the branchial sac in the older individuals is so complex and the regions so different, even in the same animal, that if there were no earlier stages to refer to it would be exceedingly difficult to arrive at sound conclusions concerning the typical relations of the various vessels.

The endostyle, in the preserved specimens, is near the extreme left edge of the branchial sac; but it is probable that in life it was somewhat closer to the sagittal plane, since the more powerful muscles of the left side would draw it away from its natural position. Its posterior end is continuous with the postbranchial groove, the most prominent edge of which connects with the right edge of the endostyle.

The dorsal lamina is represented by a series of languettes which vary from eleven to thirty-two in number. As a rule they are more numerous in the larger individuals. They extend from the posterior end of the epibranchial groove to the edge of the smooth area surrounding the œsophageal orifice, and their concave side is turned towards the right. The great dorsal blood-vessel usually accompanying the lamina runs in the mesentery of the intestine as far as the anus, and thence extends forwards, branching very irregularly. Two strong bands of smooth muscle fibres are contained in the lateral walls of this vessel.

#### THE VISCERA.

In discussing the position of the viscera, the sagittal plane is best taken as passing through the two siphons and dividing the animal as nearly as possible into symmetrical halves. This will divide the disk into approximately equal parts, except in the few cases where the siphons are considerably nearer the right side, as in Traustedt's (1887) fig. 2. In such cases, however, the plane as defined will be more nearly the plane of symmetry of the whole animal than if it were taken as cutting the disk midway between the two sides and not including the siphons.

This is apparently the plane adopted by Drasche (1884), Herdman (1891), and Traustedt (1880). But the last author in a later paper (1882) defined the sagittal plane as passing through the endostyle and ganglion. As in *C. macleayanum* the endostyle is near the extreme left, and the ganglion on the right of the line joining the siphons; this plane is nearly parallel to the disk, the siphons are on the left, and the viscera on the right side. Though on some grounds this criterion might be justified for *C. macleayanum*, it will hardly serve for the more elongated *C. productum*, in which this sagittal plane would neither contain the long axis of the animal nor divide it into approximately equal parts.

Both Drasche for *C. productum* and Herdman for the whole genus disagree with Traustedt in describing the viscera as located on the left side of the animal, and Kiaer (1893) makes the strange statement that both disk and digestive tract are on the left side. The evidence for some of these statements is seen in the figures of Eschricht (1842), Traustedt (1887), and Wagner (1885). These show that in *C. macleayanum* the viscera are either strictly ventral in position or slightly on the *left* of the median line. In *C. productum*, on the other hand, the specimens that I have examined fail to confirm Drasche's statement, for in them the major part of the digestive tract is on the *right* side of the sagittal plane (fig. 13), and this condition is more pronounced in the more elongated individuals. In the flattest of my specimens, however, the conditions found in *C. macleaynum* are more closely approximated. But more important than the question of determining whether two-fifths or three-fifths of the viscera are on the right of the midventral line is the fact that in both species all of the digestive tract, except the dorsal terminal part of the intestine, is *ventrally* situated.

Although *Chelyosoma*, since its viscera are sometimes on one and sometimes on the other side of the median plane, shows how the change from the *Corella* to the *Ascidia*

condition might be effected without passing through a stage like *Ciona*, I do not believe that it represents such a transitional condition, for the curve of the intestine is exactly like that of *Corella*. Furthermore, the position of the heart, which in *C. productum* is on the side of the stomach farthest from the midventral line, still more increases this similarity. As the general course of the digestive tract in our species is exactly like that of *C. macleayanum* a detailed description is unnecessary.

The epithelium of the ventral wall of the stomach is thrown into folds forming a deep groove which extends from the entrance of the œsophagus to the exit of the intestine. From the outside these appear as a series of longitudinal lines that have often been described. The rest of the stomach has its surface area increased by the formation of pocket-like projections which give it a very characteristic appearance in the surface view (fig. 14). A reticulate gland with a single duct opening into the stomach covers its pyloric portion and the adjacent intestine. This gland presents all the features of the one described by Winiwarter (1895), except the large number of separate ducts. The intestine is quite simple and does not possess a typhlosole.

The sexual organs are much like those described for *C. macleayanum* by Wagner. Both ovary and testis are a complicated system of dichotomously branching tubes which never reunite. They extend both ventrally and dorsally to the digestive tract, and in the older individuals, with the assistance of the pyloric gland, they completely cover it. Their ducts follow the course of the intestine and open in the immediate vicinity of the anus. Figure 14 represents these organs in a young animal.

#### CONCLUSION.

This account of the structure of *Chelyosoma* shows that it is even more closely related to *Corella* than was formerly supposed. In fact, it agrees with *Corella* in all the characters which differentiate the latter from *Ascidia*. On the

other hand, all of its distinguishing characteristics are of a very exceptional kind. Thus, the division of the test into plates is shared by only one other species of tunicate, *Forbessella tessellata*, while the attachment of the muscles and their definite relations with the plates are, so far as known, unique. The lacunar character of the blood-vessels in the test, asymmetrical hypophysial gland, and single peripharyngeal band are also unusual.

Of the two species of the genus, *C. macleayanum* presents on the whole fewer aberrant characters and is nearer the direct line of descent from some Corella-like ancestor. Its exceedingly depressed form is more unusual than the shape of the western species; but on the other hand, the youngest individuals of *C. productum* are very much flatter than the older ones, thus indicating a depressed ancestor. The difference in the musculature also furnishes very strong evidence for believing *C. macleayanum* the more primitive type; for we can easily see how a division of the test into plates with the muscles extending perpendicularly to the hinges might be developed from a form with an irregular mass of muscles confined to the dorsal side of the animal. Then, when the plates are once formed, the condition in *C. productum* could be obtained by increasing the peripheral muscles. On the other hand, it is very difficult to see how the peripheral plates could ever have been developed directly by a system of muscles extending parallel to the hinges. In the more recent development of *C. productum* then, we have what appears to be the reason for its unstable condition, and the attendant variability in those characters which distinguish it from the other member of the genus.

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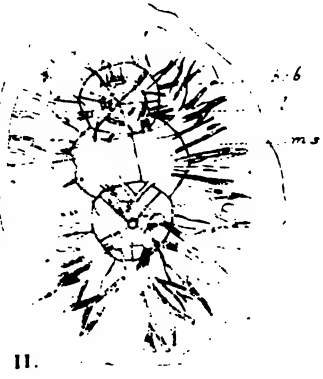
## EXPLANATION OF PLATE XVIII.

All the figures except Nos. 1, 2, 2a, and 13 were drawn with the aid of the camera.

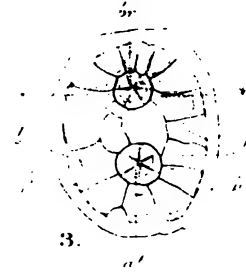
- Fig. 1. A large Puget Sound individual from the left. Natural size.  
 Fig. 2. A regularly shaped California individual from the left; x 2.  
 Fig. 2a. Same individual; dorsal view.  
 Fig. 3. The disk, showing the arrangement of the plates, and the lines indicating the boundary of their central thickened portion; *br*, branchial siphon; *at*, atrial siphon; *c*, central plates; *l*, lateral plates; *p*, peripheral folds; \* points where the accessory central plates may be formed. Natural size.  
 Fig. 4. Cross-section through a plate and the two hinges (*h*, *h'*) at its edges, showing the yellow layer (*y. l*), test papillæ (*t. p*), and ectoderm (*ec*); x 28.  
 Fig. 5. The yellow layer, more highly magnified, showing an isolated mass of yellow substance surrounding a bladder cell (*c*) and two masses (*a*, *b*) which have just fused with the yellow layer; x 830.  
 Fig. 6. Section through the ectoderm and part of the cellulose layer, showing the remains of ectoderm cells imbedded in the latter; x 830.  
 Fig. 7. A group of bladder cells.  
 Fig. 8. Bladder cells, overstained in Iron-Hæmatoxylin to show their slender processes into the test; x 830.  
 Fig. 9. Various stages in the formation of the yellow substance about the bladder cells; x 830.  
 Fig. 10. A test papilla showing the attachment of a muscle fibre (*m*) by means of the ectodermic pockets (*pt*); *a* and *d* are the points where the ectoderm has been torn from the test; x 380.  
 Fig. 11. The muscles of the disk from within; *m. s*, the short exterior muscle fibres; *pc. b*, the peripharyngeal band. The outlines of the plates are indicated by the heavy black lines; x 2.  
 Fig. 12. Branchial sac of a very young individual; *o*, outer vessels; *i*, intermediate vessels; *u*, points of union between the outer and intermediate vessels; x 130.  
 Fig. 13. An individual with the ventral part of the test removed, from the right side, showing the course of the digestive tract. \* indicates the position of the heart; x 2.  
 Fig. 14. A younger individual; ventral view, but slightly from the right, showing the ovary (*o*) and testis (*t*). Test entirely removed; x 5.



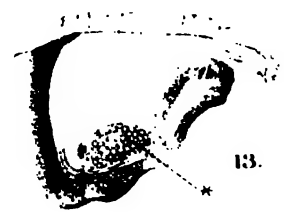
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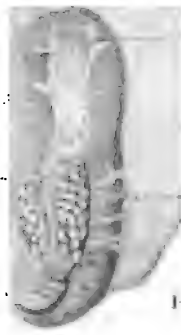
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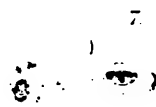
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PROCEEDINGS  
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ZOOLOGY.

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The Gordiacea of Certain American  
Collections, with Particular Reference  
to the North American Fauna.

I I.

BY

THOMAS H. MONTGOMERY, JR., PH.D.,

*Lecturer in Zoology, University of Pennsylvania.*

WITH TWO PLATES.

*Issued October 12, 1898.*

SAN FRANCISCO:  
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THE GORDIACEA OF CERTAIN AMERICAN  
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ERENCE TO THE NORTH AMERICAN  
FAUNA.—II.

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PLATES XIX AND XX.

THE present paper deals with Gordiacea, principally of California, and with a few specimens from neighboring regions (Baja California, Arizona, Nevada, and Mexico). The fauna of California has been heretofore but little known, so that the comparatively large number of specimens from that locality which have been offered to me for study have a special interest. In a previous contribution<sup>1</sup> Gordiacea were described by me from other portions of North America.

The following collections are herein described: that of the California Academy of Sciences, San Francisco; of the University of California; and of Stanford University, California. For the opportunity to study these collections, my thanks are due to Dr. Gustav Eisen of the California Academy of Sciences, and to Prof. Henry B. Ward of the University of Nebraska.

Appended to this paper is a Key for the determination of the species of Gordiacea on the North American continent, north of Mexico. While this key may serve to determine with rapidity certain species, it must be noted that some of them, and particularly the females of *Gordius* and *Chordodes*, can only be satisfactorily determined by means of sections and of portions of the cuticle cleared in glycerine or some clearing oil (I am accustomed to clear them in cedar oil, after dehydration, and to study them mounted in Canada balsam). For descriptions of species which are

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<sup>1</sup> Bull. Mus. Compar. Zool., Harvard University, April, 1898.

here mentioned only briefly, the reader is referred to my previous paper, l. c. In this Key the females of *Gordius aquaticus difficilis*, *G. longareolatus*, n. sp., *Chordodes puerilis*, and the male of *C. morgani* find a place, though I have seen only the males of the first three mentioned, and the female of the last; this was done with the assumption that the cuticular characters of the two sexes are similar in these forms.

It is here shown that *Chordodes gordioides* Montg. is identical with *C. occidentalis* Montg.

### 1. *Gordius longareolatus*, sp. nov.

*Type*.—Coll. Cal. Acad. Sci.: 1 ♂, San Francisco, Cal., Sept. 10, 1896.

*Form*.—Of equal diameter in its whole length, nearly cylindrical, with faint median grooves. Head end (fig. 1) conically rounded, the tip slightly constricted off, mouth ventral (on the ventral side of the white tip of the head). Tail lobes (figs. 1, 3) short, thick, nearly parallel, terminally rounded. Their point of bifurcation (on the ventral surface) is at a distance from the oval cloacal aperture about equal to the length of the lobes. Each lobe is approximately cylindrical, except on its median surface which is concave; this concavity is deepest nearest the posterior end of the lobes and is bounded by a sharp line. The cloacal aperture is situated upon a slightly elevated papilla; from this papilla to the point of bifurcation of the tail lobes extends a deep groove (deepest caudad). The area around the cloacal aperture, and extending caudad to about the point of bifurcation of the tail lobes, is covered with numerous, minute, conical spines.

*Cuticle*.—With elevated areoles of elongate form, their longitudinal axes parallel to that of the body (fig. 4). The areoles do not produce particular longitudinal rows, though everywhere the spaces which separate them are about equal in length. They are darker than the intermediate portions of the cuticle. Most of them are several times longer than broad, with nearly parallel margins; a smaller number are shorter and thicker, but even these are somewhat elongate. On cross section of the body (fig. 5) the areoles are seen to be hyaline and homogeneous, their darker, denser bases sunk into the surface of the fibrous cuticle. On section they show a rounded-conical form, without any median groove. No hairs lie between the areoles, but widely separated from one another are found a few hyaline, finger-shaped processes, of slightly greater elevation than the areoles; such processes have heretofore been noticed by me only in the genus *Chordodes*.

*Color*.—Deep olive brown, slightly iridescent; the tip of the head white.

*Dimensions*.—Length, 115 mm.; greatest diameter, 0.5 mm.

*Comparison.*—The only other Gordiacea with longitudinally arranged elongate areoles are *G. raphaelis*, *alfredi*, and *latastei* of Camerano, and *G. abbreviatus* Villot; but all of these differ from *G. longiareolatus* in having the areoles longitudinally grooved.

## 2. *Gordius aquaticus* Linn.

Coll. Cal. Acad. Sci.: 2 ♂♂, City of Mexico; 2 ♂♂, Berkeley, Cal., winter of 1891. Coll. Univ. of Cal.: ♂, Berkeley, Cal., January, 1895.

These are the only specimens as yet seen by me of the true *aquaticus* from North America; in all of them the white spots (figs. 13, 14) are clearly marked on the surface of the cuticle and may be seen with a low-power hand lens.

## 3. *Gordius aquaticus robustus* (Leidy.)

Coll. Cal. Acad. Sci.: ♀, San Francisco, Cal.; ♀, Berkeley, Cal. Coll. Univ. Cal.: ♀, Berkeley, Cal., January, 1895.

The largest specimen measured 590 mm.

This is the form, corresponding to *G. robustus* Leidy, which has been regarded by me (l. c.) as a mere variety of the preceding, from which it differs merely in the absence of the white cuticular spots. In the true European *aquaticus* the white spots are present in most individuals, according to the description of Römer<sup>1</sup>; while in specimens of *robustus* from the eastern United States (from Kansas eastward) I have never found these spots, though I have studied one or two hundred specimens. Westward of California occurs the true *aquaticus*, eastward the *aquaticus robustus*, while in California the two appear to overlap. If white-spotted specimens be subsequently found in any number from the eastern United States, then *aquaticus robustus* can no longer be retained as a separate subspecies; but with the facts at hand we are justified in assigning it that position.

<sup>1</sup> Beitrag zur Systematik der Gordiden Abb. Seckenberg. Ges., Bd. XXIII, 1896.

#### 4. *Gordius densareolatus* Montg.

Coll. Cal. Acad. Sci.: ♂, Lake, San Francisco, Cal.

The posterior end of this specimen was as in the type (cf. Montgomery, l. c.), except that there was only a slight precloacal groove.

In my first description of this species (l. c.) the cuticle of the female only was described. I have since re-examined the type of the male (Montana, Leidy coll., No. 5063) and find the cuticle in general like that of the female, except that the areoles show less tendency to confluence and are more rounded in outline.

#### 5. *Paragordius varius* (Leidy.)

Coll. Cal. Acad. Sci.: 2 ♂♂, 3 ♀♀, San José del Cabo, Baja Cal., July, 1896; ♀, St. Helena, Napa Co., Cal. Coll. Stanford Univ., collected by C. H. Gilbert: 5 ♀♀, Napa Creek, Calistoga, Napa Co., Cal., May 31, 1897.

This appears to have the broadest range of any North American species, extending completely across the continent, and, according to Camerano, into South America.

In the females the tail lobes may be either parallel or divergent, so that they are probably opened and closed by muscular action; while in the males of this genus and of *Gordius* these lobes appear to be to great extent independent of such action.

#### 6. *Chordodes occidentalis* Montg.

Coll. Univ. Cal.: ♂, ♀, Berkeley, Cal. Coll. Stanford Univ., collected by C. H. Gilbert: 112 ♂♂, 42 ♀♀, Napa Creek, Calistoga, Napa Co., Cal., May 31, 1897. Coll. Cal. Acad. Sci.: 2 ♀♀, 1 ♂, Haywards, Alameda Co., Cal.; 1 ♀, Alameda Co., Cal.; 2 ♂♂, 2 ♀♀, Santa Rosa Isl., Cal.; 4 ♀♀, Sierra el Taste, Baja Cal.; 1 ♀, St. Helena, Napa Co., Cal.; 1 ♀, Kings River, Fresno Co., Cal.; 1 ♂, Lime Point, Marin Co., Cal.; 1 ♂, San Miguel de Comondu, Baja Cal.; 1 ♀, 5 ♂♂, locality not marked, but probably from California; 1 ♀, Battle Mountain, Nevada.

A careful examination of this large number of specimens shows that the *Chordodes gordioides* Montg. of my preceding paper was based upon immature specimens of *C. occidentalis* Montg., so that *gordioides* is not a tenable species.



Owing to the great amount of individual variation afforded by these specimens from California (123 ♂♂, 55 ♀♀,) a description of them is necessary, and this description may be compared with that of *occidentalis* and "*gordioides*" given in my preceding contribution.

*Form.*—The form of the male has already been described and figured, so that it is only necessary to note that the anterior portion of the body is the most slender, the head (fig. 10) pointed, and the body either cylindrical or flattened (depending upon the state of development of the genital products). The females resemble the males in general form, and in them also the anterior portion (fig. 6) is the most slender, they are stouter than the males; the posterior end (figs. 9, 13) is enlarged and more or less knob-shaped as in all females of this genus; seen from the ventral surface (fig. 23) this posterior end appears disc-shaped, with the cloacal aperture in its centre.

*Cuticle.*—Thirty-two specimens were examined, cleared in cedar oil, and transverse sections were made of twenty-four of them. These preparations, with those which formed the basis of my previous descriptions, show how variable the configuration of the cuticle is in this form, and present all intermediate phases between the figs. 115-117, Pl. XV, of *C. occidentalis* of my previous description, and figs. 106, 107, Pl. XIII, l. c., of *C. "gordioides,"* and leave no doubt that the latter is only the young of the preceding.

On surface view the areoles may be irregularly polygonal and well separated from one another, or they may be elongate and confluent so as to produce transverse rows (figs. 7, 12-20). The areoles of the same individual may be all of the same color, which appears to be usually the case, or groups (of a few each) of larger areoles may be darker than the others (fig. 19). The cuticle of one specimen had the appearance of that of *Gordius pleskei* Camer., owing to the incrustation of minute dirt particles between the areoles (fig. 12). Small, refractive, circular or oval pits occur in varying number on the cuticle; they lie for the main part between areoles, sometimes on their surfaces; their most frequent mode of occurrence is between two areoles which together present a dumb-bell shape; their number varies greatly, and they are found either singly, in pairs, or in threes (figs. 7, 15-20).

On transverse section (figs. 8, 11, 21, 22) the areoles are usually of the same height but varying diameter in the same individual, but are never as high as long, though in the males they are usually higher than in the females; they are either close together or well separated. In a few specimens, as in the type first figured, lower areoles with irregularly serrated summits lie between the higher ones, but such a relation was found in only three or four cases. Between the areoles, occurring only at wide distances, are delicate finger-shaped or club-shaped hyaline processes, of greater height than the areoles. In a few specimens were noticed hyaline processes of a stout conical form, sunk into the summits of certain of the areoles (fig. 22). In some males a cup-shaped depression occurs on the summits of a few of the areoles.

The circular or oval pits seen on surface views are found on section (fig. 8) to represent structures, the like of which has not yet been described for any Gordiacean; they were overlooked in my description of the type specimen,

owing to their paucity in that individual, but I have found them on re-examination. They were largest and most abundant in a large female, and appeared to be absent in only three specimens. Each pit has the form of a sack of spherical or ovoid shape (some are flattened parallel to the surface of the cuticle), with an exterior opening on the surface of the cuticle; the length of these sacks varies from about one-fourth to two-fifths the diameter of the cuticle. On section it would appear that almost all of them lie between areoles, sunk into the fibrous cuticle, though on surface view they frequently seem to lie on the summits of areoles. The outline of each pit is rounded and sharply demarcated, though no special limiting membrane appears to be present. In each lie two (rarely three) refractive spines, which are usually situated vertical to the surface of the cuticle, but in some cases parallel to it. Each spine is somewhat rod-shaped, thickest basally, the base obtusely rounded and usually in close contact with the wall of the pit. At its distal end each spine has a short, pointed process which projects out of the narrow opening of the pit; the longitudinal axis of this pointed portion does not always coincide with that of the basal portion. Thus these spines are somewhat similar in form to the central stilets (with their bases) of the *Metanemertean* proboscis.

*Color.*—The males vary from a light yellowish, through rufous or chocolate or olive-brown, to a nearly pitch black color, smaller individuals being usually but not always lighter than larger ones. In most of them the anterior portion of the body is lighter than the posterior; the head is lightest in color, very frequently yellowish white, while the rest of the body is chocolate-brown. Just behind the light head portion is usually a more or less pronounced dark neck ring, which is seldom wholly absent. The females average much lighter in color than the males, and are usually a yellowish or yellowish brown color; a few are a dark olive-brown, but none are black. In them, too, there is usually a darker neck ring, and often a brownish area around the cloacal aperture. In both sexes the mouth aperture is usually marked by a small black spot, easily seen with a hand lens: thus of the 154 individuals collected on the same day at the same locality (coll. Stanford University), 96 males showed this spot, 15 males were without it, and in 2 males the whole head was black; and all the 42 females showed the spot. The black mouth spot would thus appear to be pretty constant (though it was absent in the type specimens of this species).

*Dimensions.*—Largest male, 460 mm.; largest female, 420 mm.

*Comparison.*—*C. gordioides* Montg. becomes a synonym of this species. This species differs from *C. bedriagæ* and *C. pardalis* Camer., to which the configuration of its cuticle appears to be otherwise quite similar, in the presence of the remarkable cuticular pits, the structure of which, however, can only be determined by sections. Such pits have never heretofore been described: but clear, rounded cavities situated just below tubercles or areoles of the cuticle

would seem to be frequent in *Chordodes*, at least I find them in my species of *C. morgani*, *C. puerilis*, and *C. albi-barbatus*, though not in *C. furnessi*.

*General diagnostic characters.*—The union of the following characters serves to distinguish this from any other North American form: the low aeroles with the remarkable interareolar pits, the attenuation of the anterior portion of the body, and the black mouth spot. The females of this species may easily be mistaken for females of *G. densareolatus* Montg., since in some specimens of the former the interareolar pits may be very few in number (or entirely wanting?). But the form of the posterior end is a good distinguishing character: in the female of *C. occidentalis* it is enlarged—somewhat knob-shaped, while in the female of *G. densareolatus* it is not of greater size than the preceding portion of the body; there is at least no difficulty in distinguishing them when one has a series of specimens of both before him.

#### KEY TO THE SPECIES OF GORDIACEA OF THE NORTH AMERICAN CONTINENT, NORTH OF MEXICO.

- I. Posterior end trilobed . . . . . *Paragordius varius* (LEIDY), ♀.
- II. Posterior end bilobed, spirally inrolled. (*Paragordius* and *Gordius*, ♂ ♂).
- A. A sharp, V-shaped cuticular ridge behind the cloacal aperture.
  - a. The cuticle dotted with white spots. *Gordius aquaticus* LINN., ♂.
  - b. The cuticle not dotted with white spots.
    1. A parabolic line of hairs on the tail lobes. *G. a. difficilis* MONTG., ♂.
    2. No line of hairs on the tail lobes. *G. a. robustus* (LEIDY), ♂.
- B. No sharp, V-shaped cuticular ridge behind the cloacal aperture.
  - a. A longitudinal line of long hairs on each side of the cloacal aperture. . . . . *G. lineatus* LEIDY, ♂.
  - b. No line of long hairs on each side of the cloacal aperture.
    1. Head end obliquely truncated. *Paragordius varius* (LEIDY), ♂.
    2. Head end not obliquely truncated.
      - a. Conical spicules behind the cloacal aperture.
        1. Tail lobes short, nearly conical. *Gordius densareolatus* MONTG., ♂.
        2. Tail lobes nearly cylindrical. *G. longareolatus* MONTG., ♂.

*b.* No conical spicules behind the cloacal aperture.

*G. platycephalus* MONTG., ♂.

III. Posterior end not lobed, spirally inrolled, with a depression or groove on its ventral surface, narrower than preceding portion of body.....(*Chordodes*, ♂ ♂).

*A.* Cuticular areoles longer than high, on and between them small circular pits.....*Chordodes occidentalis* MONTG., ♂.

*B.* Cuticular areoles higher than long.

*a.* Spines on the summits of the highest papillæ.

*C. puerilis* MONTG., ♂.

*b.* No spines on the summits of the highest papillæ.

*C. morgani* MONTG., ♂.

IV. Posterior end not lobed, not spirally inrolled.

*A.* Posterior end not noticeably enlarged.....(*Gordius*, ♀ ♀).

*a.* With elevated cuticular areoles on the whole surface of the body.

*1.* With paired dark stripes in the median lines.

*Gordius leidy* MONTG., ♀.

*2.* No dark stripes in the median lines.

*a.* Areoles elongated in the long axis of the body, well separated.....*G. longareolatus* MONTG., ♀.

*b.* Areoles not elongated in the long axis of the body.

*1.* Areoles closely apposed, tending to produce longitudinal ridges.....*G. lineatus* LEIDY, ♀.

*2.* Areoles more or less confluent, tending to produce transverse rows, head usually cylindrical.....*G. densareolatus* MONTG., ♀.

*3.* Areoles usually separated, interareolar groups of fine hairs, head usually flattened.

*G. platycephalus* MONTG., ♀.

*b.* Without elevated cuticular areoles on the whole surface of the body.

*1.* No cuticular areoles.

*a.* Cuticle dotted with white spots...*G. aquaticus* LINN., ♀.

*b.* Cuticle without white spots...*G. a. robustus* (LEIDY), ♀.

*2.* Cuticular areoles at the ends of the body only.

*G. a. difficilis* MONTG., ♀.

*B.* Posterior end swollen, somewhat knob-shaped, slightly constricted off.....(*Chordodes*, ♀ ♀).

*a.* Cuticular areoles longer than high, on and between them small circular pits.....*Chordodes occidentalis*, MONTG., ♀.

*b.* Cuticular areoles higher than long.

*1.* Spines on the summits of the highest areoles.

*C. puerilis* MONTG., ♀.

*2.* No spines on the summits of the highest areoles.

*C. morgani* MONTG., ♀.



## EXPLANATION OF PLATE XIX.

(All the outlines were drawn with the aid of the camera lucida and a Zeiss microscope and lenses. The cuticle is represented as seen in Canada balsam, after clearance in cedar oil.)

- Fig. 1. *Gordius longareolatus*, sp. nov., type. Head end (obj. A, oc. 2).  
 Fig. 2. Idem. Ventral view of posterior end (idem).  
 Fig. 3. Idem. Lateral view of the posterior end, the ventral side to the left (idem).  
 Fig. 4. Idem. Surface view of the cuticle, the arrow denoting the line of the longitudinal axis of the body (obj. C, oc. 4).  
 Fig. 5. Idem. Transverse section of the cuticle (homog. immers. 1/12, oc. 2).  
 Fig. 6. *Chordodes occidentalis* MONTG., dorsal view of the head of a female (obj. A, oc. 2).  
 Fig. 7. Idem. Surface view of the cuticle (obj. C, oc. 4).  
 Fig. 8. Idem. Transverse section of the cuticle (homog. immers. 1/12, oc. 4, tube length 180 mm.).  
 Fig. 9. Idem. Lateral view of the posterior end, the ventral side to the right (obj. A, oc. 2).  
 Fig. 10. *Chordodes occidentalis* MONTG., male. Lateral view of the head end (obj. A, oc. 2).  
 Fig. 11. Idem. Transverse section of the cuticle; in this figure, as in the following, dirt granules are imbedded between the areoles (homog. immers. 1/12, oc. 2).  
 Fig. 12. Idem. Surface view of the cuticle (obj. C, oc. 2).  
 Fig. 13. *Gordius aquaticus* LINN., male from Berkeley, California. Surface view of the cuticle; the intersecting clear lines transverse the white spots (obj. C, oc. 2).  
 Fig. 14. Idem. Surface view of the body, as seen with low magnification (obj. A, oc. 2), to show the arrangement of the white spots. The continuous lines represent the outlines of the body, the dotted lines the area to which the drawing was limited.

1.

2.

3.

4.

5.

6.

8.

7.

9.

11.

13.

12.

10.







EXPLANATION OF PLATE XX.

All figures refer to Californian specimens of *Chordodes occidentalis* MONTG.

**Figs. 15-20.** Surface views of the cuticle of different individuals, fig. 20 from a female, the others from males (obj. C, oc. 4).

**Figs. 21, 22.** Transverse sections of the cuticle of a male and a female (homog. immers. 1/12, oc. 2).

**Fig. 23.** Female, ventral view of the posterior end (obj. A, oc. 2).

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BY

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WITH ONE PLATE.

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# OBSERVATIONS ON MONOGENESIS IN METRIDIDIUM.

BY HARRY BEAL TORREY.

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## I. INTRODUCTION.

THE MATERIAL for this investigation was furnished by *Metridium fimbriatum* Verrill, an extremely abundant species in the harbor of Oakland, Cal. It is practically identical, according to Verrill, 1868, with *M. marginatum* of the eastern coast, and *M. dianthus* of Europe; these three species being distinguished without doubt solely on account of their wide separation geographically.

The animals were found crowded together in great numbers upon the piles supporting the two railroad bridges which cross the estuary. They range as high as three feet above mean low-water mark. The water is brackish, and at ebb tide is exceedingly dirty. They are quite hardy and may be kept indefinitely in aquaria. Several specimens have been in captivity since October, 1897; yet they are not so vigorous as they were in their natural environment. The change in their conditions of life has probably served to retard the processes of asexual reproduction described hereafter.

Tullberg's method of killing and hardening anemones for macro-sectioning, as recommended by Parker, 1897, gave satisfactory results. Magnesium sulphate in strong solution was added to the water containing the animals until they were thoroughly narcotized. They were then placed in a one per cent. solution of chromic acid for several hours. Serial sections were usually taken with a razor, a method which showed satisfactorily, among all but the smallest specimens, the arrangement and behavior of the mesenteries, mesenterial muscles, and siphonoglyphs. The smallest specimens were sectioned on the microtome.

In the latter part of September, 1897, a large specimen of *Metridium fimbriatum* was brought to the laboratory. Upon expansion it was found to have divided partially into three individuals. There were two complete circlets of tentacles, one of which enclosed two mouths, the other but one. The oral disks had but just separated. No trace of division existed beyond the parapet.

More monogenous polyps were found in small numbers in the months of October, November, January to June inclusive. At present I am unable to say whether they are in greater abundance during some seasons than others. Among 1971 polyps collected at random in May and June, 48 (2.43 per cent.) were monogenous. The diameter of the column when well expanded varied from 2 to 30 mm. Sexual elements may be present.

Three modes of monogenesis have been observed:—

1. Longitudinal fission.
  - a. Equal.
  - b. Unequal.
    - Oral-aboral.
    - Aboral-oral.
2. Basal fragmentation.
3. Budding.
  - a. Pedal.
  - b. Œsophageal.

No case of transverse fission (Agassiz 1865) has as yet come under my notice.



## II. LONGITUDINAL FISSION.

(a.) *Equal*.—The equality here is only approximate. No perfectly equal fission has been observed, which is hardly to be wondered at in such a variable genus as *Metridium*.

Three cases of equal fission have been seen. The best example is shown in section in fig. 1. This figure is drawn to show the arrangement of the mesenteries and siphonoglyphs in the œsophageal region, looking toward the mouths from within. The six mesenteries diverging from *B*, three running to each œsophagus, and the two mesenteries, one bearing a mesenterial filament, which run between the two œsophagi, are below the plane of the section.

While the symmetry is not absolute, it is still striking. At *D* and *D'* are the two pairs of directives, indicating the siphonoglyphs, symmetrically placed to the plane of division passing through *A-B*. There are eleven pairs of complete mesenteries symmetrically placed with respect to the plane of division; five pairs to each œsophagus, and one pair divided, one member going to each œsophagus. The incomplete mesenteries comprised between every two adjacent pairs of symmetrically placed complete mesenteries are, with the exception of the two sections 1-2 and 1'-2', remarkably symmetrical for such a variable species.

(b.) *Unequal*.—This is the usual mode of division. Its later stages cannot always be distinguished with certainty from budding. Fifteen undoubted cases have been observed. The progress of the division is as a rule from the oral toward the foot disk. One specimen has been taken, however, which was dividing in the reverse direction, as described by McCrady, 1858, for *A. cavernosa*. The foot disk had divided completely, and the plane of division had parted the column for one-third of its length. The animal died soon after its capture, which prevented dissection.<sup>1</sup>

---

<sup>1</sup> Since this was written, the pedal disk of a polyp in the laboratory was accidentally torn into two portions. These, upon healing of the surfaces of the wound, have remained distinct, two apparently well-formed pedal disks being the result. The exception mentioned in the text may have been due to a similar cause.

Seven cases were dissected, each in a stage shortly after the division of the mouth. In but one had the mouth divided transversely (fig. 2.) The single siphonoglyph, lying at one end of the mouth, was therefore not included in the division, but remained intact as the siphonoglyph of the larger œsophagus. There was no sign of a siphonoglyph upon the other mouth.

In each of the other six cases the division plane had passed through the greater axis of the mouth, dividing the siphonoglyph into two portions, one pertaining to each of the two new œsophagi. Figure 3 shows the siphonoglyph dividing, slightly in advance of the division of the œsophagus. Figure 3*a* is toward the aboral end of the œsophagus; neither siphonoglyph nor œsophagus has divided. Figure 3*b* is a section taken nearer the oral disk; the siphonoglyph here exhibits a median fold marking the line of division, and the œsophagus is constricting longitudinally. A section taken above the point of junction of the two newly formed œsophagi is shown in fig. 3*c*; the siphonoglyph has divided, and each portion, by the division of the primary pair of directives, possesses but one directive mesentery. The plane of division has passed between the members of pair *m*, also, so that each œsophagus (3*c*) obtains one mesentery.

A similar case is shown in figs. 4*a* and 4*b*, which are drawn from a diglyphic polyp with an unusually large number of complete mesenteries. But one siphonoglyph is affected by the division; so that the smaller derivative œsophagus possesses two siphonoglyphs, the larger, one. The mesenteries of the pair of directives *D*, and non-directives *m* are apportioned as in the preceding case. This separation of the members of a pair is characteristic of longitudinal fission.

Somewhat later stages are shown in figs. 5 and 6, in each of which the derivative œsophagi are distinct throughout their length. While the siphonoglyphs in each polyp are entirely separated, they are still closely related in position; and the directives exhibit the divergence characteristic of

the division in the first two cases. The remaining two cases were essentially similar to that shown in fig. 3*c*, though more nearly equally divided. Figure 4 represents a diglyphic polyp. Figure 6 in all probability represents the result of the division of another diglyphic polyp. This is an unique case. The plane of division seems to have passed through both siphonoglyphs of the original polyp, as indicated by the division of the two pairs of directives. The siphonoglyphs, immediately upon their division, were probably approximated by the longitudinal constriction of the œsophagus which usually follows the division of a siphonoglyph. Opposite halves of the divided siphonoglyphs could then unite by their inner edges to form the two derivative siphonoglyphs, one on either side of the plane of division.

There are reasons for believing that this method of division so plainly exhibited in the foregoing six cases is the usual one. In each of the eight remaining cases of longitudinal fission (excepting the single instance of division transversely to the mouth) there is a marked symmetry in the position of the siphonoglyphs with respect to the plane of division. This has been alluded to already in connection with fig. 1, where the greater axes of the mouths, passing through the siphonoglyphs, form with the plane of division angles of 25 degrees. In fig. 7 these angles are about 15 degrees; in fig. 8, 45 degrees. In five other specimens the angles are respectively 45, 35, 35, 15, 0 degrees.

The smallness of these angles suggests the conclusion that each pair of diverging siphonoglyphs has arisen from a single siphonoglyph by longitudinal fission. This conclusion is supported by the conditions found in figs. 7 and 8. The triglyphic type is exceedingly rare, two instances having been counted among 451 individuals. This decidedly lessens the probability that these two cases were originally triglyphic polyps. Moreover, each could be derived from fig. 4 by the completion of the directives and the introduction of two pairs of non-directives between the pairs of directives. Such cases as the one represented in fig. 1

could be derived from fig. 3c by the completion of the directives and the interposition of two pairs of non-directives between the directives. Although these assumptions cannot at present be fully tested, they yet receive considerable support from the facts that a single *Metridium* is never found with an incomplete pair of directives; and that the two mesenteries of a pair frequently vary, independently of each other, in breadth (pair *i*, fig. 3). In a case of budding, to be mentioned again later, the bud, having received but one directive mesentery from the parent, had grown a second to complete the pair. It is probable, then, that complete mesenteries have arisen, after the division of the siphonoglyphs, between the pairs of directives (figs. 1, 7, 8).

Further investigation only can establish the relative frequency of those divisions which include the siphonoglyph to the total number. But it seems fair to conclude that since the plane of division of 40 per cent. of the total number of dividing polyps examined has passed through at least one siphonoglyph, there exists in *Metridium* a predisposition to divide in this manner.

Division, then, in *Metridium*, is probably initiated by a longitudinal splitting of a siphonoglyph. A constriction of the mouth follows, resulting in the formation of two mouths in the place of the one, each mouth obtaining a portion of the original siphonoglyph. The division plane usually proceeds aborally, and may almost completely sever the two portions of the œsophagus before any constriction becomes apparent in the oral disk. An irregular line of tentacles grows in between the two mouths; the constriction of the oral disk, proceeding inward, gradually separates these into two series, dividing the oral disk into two parts. The parapet next divides by means of a similar constriction. A longitudinal groove on each side of the column now marks the course of the division plane; and at about this stage the mesenteries of the foot disk (which is semitransparent) are seen to be arranged about two centers of radiation. I have not been able to follow this rearrangement. The furrow between the newly formed oral disks gradually deepens.

The rate of fission is exceedingly slow, for I have not observed a single instance of full severance of individuals, though a number of dividing polyps have been kept in the laboratory for nine months. The artificial conditions of the aquaria may serve as a retarding factor.

Some of the divisions are of marked inequality. In one case three perfect pairs (*i. e.*, in which both mesenteries reach the œsophagus) and two half-pairs of complete mesenteries radiate from one œsophagus, nine perfect and three half-pairs from the other; total, fifteen pairs. In fig. 3*c* five complete mesenteries reach one œsophagus, ten the other; total, eight pairs. Mesentery *i*, incomplete in fig. 3*a* and 3*b*, finally reaches the œsophagus in fig. 3*c*. In fig. 8 the siphonoglyphs are unequally apportioned: the œsophagus with two siphonoglyphs possesses two and one-half pairs of non-directives, the monoglyphic œsophagus, five and one-half pairs of non-directives; total number of complete mesenteries, eleven pairs. In fig. 4, fifteen mesenteries reach the diglyphic, thirty-one the monoglyphic œsophagus; total, twenty-one perfect pairs, four unpaired, or imperfect pairs. Figures 5 (thirteen pairs) and 6 (eleven pairs) exhibit striking inequalities in apportionment of mesenteries between the two œsophagi. In fig. 7, six of a total of eleven pairs reach one œsophagus, five the other. In another case, eleven and one-half pairs are distributed as equally as possible to the two œsophagi. So great are the discrepancies in number and distribution of mesenteries in these cases, that no definite relation between monogenesis and the number and position of mesenteries can be asserted.

Advanced stages of unequal fission may be distinguished from budding usually by an external examination only, if the polyp be living. The bases of the mesenteries are readily seen as dark lines through the semitransparent walls. In fig. 9 is represented a plan of the mesenteries in the angle between the two individuals of a dividing polyp, seen from above. Only two pairs of mesenteries from *A* run into pairs from *B*. These form two *P*'s, the stalks of which run down the sides of the common column. All the

other mesenteries in each polyp remain distinct from those of the other throughout their length. This is a condition one would expect to meet in a case of fission, but not in budding, as will be shown later.

### III. BASAL FRAGMENTATION.

*Laceration.*—This process has been described for two species of *Aiptasia* and one species of *Bunodes*, by Andres, 1882. Several cases have come under my notice. On March 29, 1898, two small fragments of a pedal disk were found attached to the side of a dish in which several anemones were kept. On April 5th, one of the fragments had disappeared, the other had rounded itself up into the shape of a contracted individual, and possessed a few tentacles. A few days later it had become an apparently well formed individual. The cavity in the fragment was a portion of the cavity of the original polyp from which the fragment came.

On April 5th, the *Metridium* obtained on September 27th, which was in process of division into three individuals, was found with a gaping wound in the base of the column and foot disk. The large fragment which had been torn from it was near by. It rounded itself up as the others had done. By April 23rd, it had produced two individuals which remained connected by a common base; they had probably arisen independently as buds. By the use of sections their mesenterial systems were seen to be entirely distinct. One individual was diglyphic, the other monoglyphic. There was no sign of a previous connection between any two of these; the directives were distinct throughout. There were six and one-half pairs of complete mesenteries in one individual, six complete and two pairs of incomplete mesenteries in the other. Their arrangement in the latter was according to the formula:—

$$D-2-D'-4-5-6/2-7-8/2.$$

*D* and *D'* are the directives. The asymmetry of their positions is noteworthy. It should be noted also that the polyp from which this fragment came was sexually mature and was itself dividing.



One case of this laceration was observed in a polyp in its natural environment. All the others occurred in aquaria, where the conditions were not so favorable. This unfavorable environment may have had some influence in initiating this method of reproduction which was not begun by certain polyps until they had been in captivity for more than six months, when fragments were thrown off, occasionally three or four at a time.

#### IV. BUDDING.

Buds may occur either upon the upper surface of the expanded foot disk or in the region of the œsophagus. In the first case, the bud is always, relatively to the parent, very small, and its œsophagus and siphonoglyph are formed independently of the corresponding structures of the parent. In the second, the bud may almost equal the parent in size; its œsophagus arises from the œsophagus of the parent; its siphonoglyph may be independent of the siphonoglyph of the parent from the beginning, or the siphonoglyph of the parent may enter the bud, in which case the bud possesses two instead of one.

(a.) *Pedal—Budding from foot region.*—Seven polyps have been taken with these marginal buds. In one of these cases the bud has broken away from the parent; in another the process of division is advanced; in the others it has not yet begun, although the polyps have been under observation for several months.

In the earliest stage seen, the bud was a small rounded protuberance near the edge of the foot disk. In the course of preparation for sectioning it was lost. All the other specimens were in an advanced stage and bore tentacles when collected.

The rate of detachment is low, to judge from observations taken in the laboratory, where the conditions are not favorable. The only bud which has become free in the laboratory aquaria was taken March 30th. On April 5th it was seen to be detaching. The expansion of the foot disk on

which it rested was exceedingly flat and formed a decided lobe connected by an isthmus of about half its diameter with the parent. The walls of the lobe were quite thin, enclosing a portion of the cavity of the parent. On April 14th the only change was a greater attenuation of the connecting isthmus. On April 23rd the bud was free. Neither individual showed the least sign of rupture; the base of the bud was definitely contoured before separation took place. This, therefore, is not equivalent to the laceration described by Andres, where the fragment is either torn away, or is detached by degeneration of the intermediate tissue.

At least eighteen days, in all probability longer, were consumed in completing the process. The bud possessed one siphonoglyph and six and one-half pairs of complete mesenteries.

On May 2nd, a slight constriction was observed between a second polyp and its marginal bud, producing a lobe similar to but less pronounced than that mentioned in the first case. The foot disk was elongated in the plane passing through the two individuals. On May 6th, the mesenteries of the bud, as indicated on the foot disk, radiated around the oral-aboral axis. Three only belonged also to the parent. No further change has been noted.

(b.) *Budding in the Œsophageal Region.*—Six cases of this mode of monogenesis have been dissected. The earliest stages have not as yet been obtained. The advanced stages appear at first sight identical with cases of unequal fission; but it may be seen in an external examination of a typical specimen that the mesenteries of the bud are continuous with those of the parent. This continuity demonstrates that this is a case of budding and not fission; since the two sets of mesenteries of two individuals formed by the latter process are almost totally independent of each other (fig. 9).

Upon dissection it was found that three pairs (1, 2, 3) of complete mesenteries of the parent (seen in cross section in fig. 10a) and all the incomplete mesenteries included between them, enter the bud *B*. The three pairs of complete mesenteries form the six pairs (1, 2, 3, 1', 2', 3',) of



complete mesenteries of the bud (seen in cross section in fig. 10*b*). Pairs 1 and 3 are bent sharply from their courses in entering the bud. One member of pair 3 does not reach the œsophagus of the parent just below the œsophagus of the bud, which accounts for the imperfect pair 3' in the bud. A ring of stomata pierces the mesenteries around the mouth of the bud (fig. 10*c*). Neither the siphonoglyph of the parent nor the corresponding pair of directives (*D*, fig. 10*a*) enter the bud, where no such structures were seen. When formed they must arise independently of those of the parent. The two œsophagi, however, are in communication, and probably have been from the first.

In another instance, the siphonoglyph of the parent has been drawn into the bud. Figure 11*a* shows the parent and bud, each sectioned through the œsophagus. The parent has two siphonoglyphs, as indicated by the two pairs of directives *D* and *D'*. Of these, pair *D'* alone enters the bud, forming pairs *d* and *d'*. The distortion of the directives which results is accompanied by a corresponding distortion of the siphonoglyph (fig. 11*b*). Here the observer is supposed to be looking through the mouth of the bud from within the œsophagus of the parent; *s, s* indicate the siphonoglyph of the parent; *e, e* the edges of a cut across the œsophagus of the parent and longitudinally to the œsophagus of the bud, reaching the mouth of the latter; *r* is a prominent ridge dividing the siphonoglyph into an oral and an aboral portion and extending to the mouth of the bud. The median groove of each portion reaches the mouth margin distinct from the dividing ridge. This disposition of the siphonoglyphs, side by side, is unique in my experience.

Of the six polyps dissected, one of which presented two œsophageal buds, the parental siphonoglyph in but three (43 per cent.) entered the corresponding buds. It seems highly probable, therefore, that the position of the bud bears no necessary relation to the siphonoglyph nor the greater mouth axis of the parent. For since the base of any bud may include the mesenteries comprised in about

one-half the circumference of the parent, one should expect to find that about one-half of the number of buds include the parental siphonoglyph.

In one case the siphonoglyph of the parent entered the bud accompanied by but one directive mesentery; a second directive with as yet no muscle band apparent was completing the pair in the bud.

#### V. COLONIES OF THREE AND FOUR INDIVIDUALS.

Four instances of the former and one of the latter have been found. Of the former, three have arisen, each by two divisions in planes perpendicular to each other, the second division affecting but one of the two individuals formed by the first; the method of formation of the fourth is doubtful. The colony of four individuals has been formed as follows: *A* (fig. 12*a*) is the original polyp, shown diagrammatically. *B* has arisen as a bud upon *A*, directly opposite to the one siphonoglyph. *C* and *D* arose as one bud upon *A*, at a lower level, this bud dividing later into the definitive individuals which have a common oral disk. Figure 12*b* represents a section of the column at the level *xy*. Figure 12*c* represents a section through the œsophageal region of *C* and *D*, to show the arrangement of their mesenteries. Mesenteries 1, 2, 3, 4, 6, 7, 8 (fig. 12*b*) appear in *C-D* (fig. 12*c*). Pair 3-4 has divided, orally to *C-D*, one mesentery going to each œsophagus; while aborally to *C-D*, both mesenteries (3'-4') are joined to *C*. This irregularity is correlated with the twist the bud *C-D* has suffered in the course of its division, for the inner ends of the œsophagi of *C-D* are in a line at right angles to that connecting their mouths. A further irregularity consists in the behavior of mesentery 8, which in *D* is incomplete orally, complete aborally. Also mesentery 5 does not enter the bud, although its mate, 6, incomplete in the parent, forms a single complete mesentery in *D*. And again, the incomplete mesentery 7, unpaired in the parent, forms two complete mesenteries in *D*. No directives nor siphonoglyphs could be seen in *B*, *C*, and *D*.

The formation of complete mesenteries in the bud from incomplete mesenteries in the parent is again seen in fig. 11a, where pair *c* is formed from the incomplete pair immediately above it in the parent.

These colonies have manifestly no definite architecture such as is possessed by *Amphihelia* and other of the Madrepোরaria. Whether the great diversity of methods of asexual reproduction in *Metridium* indicates a decline from a former widespread colonial habit, future investigations must decide. The percentage of monogenetic polyps is too small to make it probable that monogenesis assists *Metridium* in its struggle for existence. Nor does it seem more probable that, with the possible exception of basal fragmentation, it can be accounted for on purely physiological grounds.

Parker, 1897, has suggested the possibility that the monoglyphic and diglyphic types of *Metridium* may be of the value of varieties, "the products, one of the sexual, the other of the asexual mode of reproduction." My observations lead to an opposite conclusion. Both monoglyphic and diglyphic polyps reproduce by fission; and both may result from fission (figs. 3-7). Further, a bud from the œsophageal region may possess either one or two siphonoglyphs. One bud produced upon the foot disk had, at the time of liberation, but one siphonoglyph. Again, as has already been mentioned, two buds were found to have arisen independently from a single basal fragment: the one is monoglyphic, the other diglyphic. There can be little doubt, then, that the monoglyphic and diglyphic types are not of the value of varieties; such variation is not correlated with the process of asexual reproduction.

## VI. SUMMARY.

Monogenesis is a well established process in *Metridium fimbriatum*; longitudinal fission, laceration, and budding from œsophageal and foot regions occur. Monogenous individuals may be sexually mature.

The plane of division tends to pass through at least one siphonoglyph. There is no apparent relation between the process of division and the number and position of the mesenteries.

Laceration may be due to unfavorable environmental conditions. It may occur in dividing polyps.

Buds arise from the œsophageal and foot regions. An œsophageal bud may occupy any position relatively to the siphonoglyph of the parent, and its siphonoglyph may be independent of that of the parent.

Both budding and fission may occur in the same colony.

Variation in the number of siphonoglyphs is not correlated with asexual reproduction. The monoglyphic and diglyphic types are not of the value of varieties.

That identical structures arise from quite different sources by different processes is significant.

It is hoped in a future paper to extend these observations and add others on the origin and histogenesis of the bud, rate of fission and bud formation, relation of budding to fission, etc.

This investigation was undertaken at the suggestion of Professor W. E. Ritter, to whom I am further indebted for many helpful counsels.

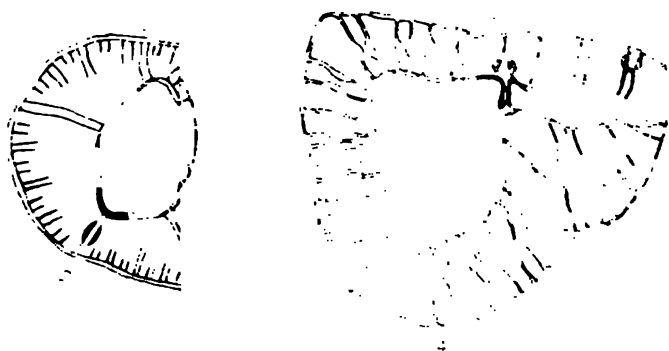
ZOOLOGICAL LABORATORY, UNIVERSITY OF CALIFORNIA,  
BERKELEY, CALIFORNIA,  
July 1, 1898.

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## EXPLANATION OF PLATE XXI.

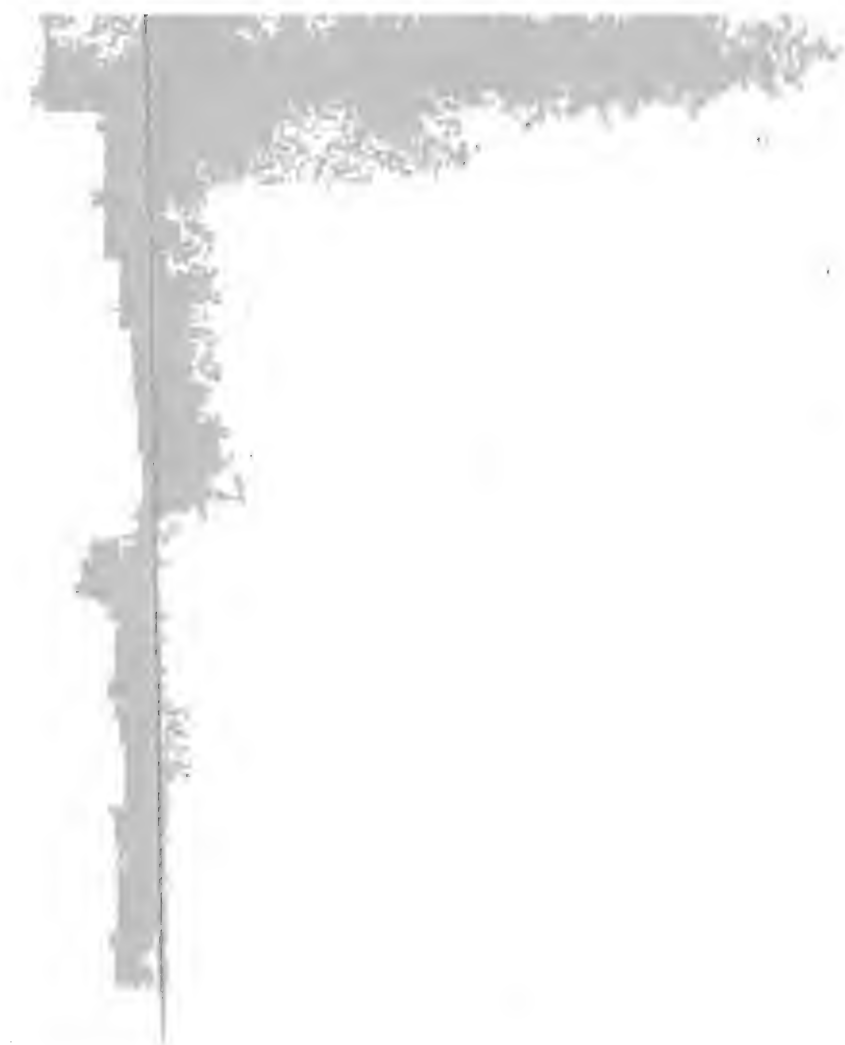
- Fig. 1. Cross section through the œsophageal region of a polyp in process of approximately equal division. *D, D'*, directives.
- Fig. 2. Single case of transverse division of the mouth; surface view.
- Fig. 3. Three sections through the œsophageal region of a dividing polyp, to show the oral-aboral longitudinal division of the siphonoglyph.
- Fig. 4. Two sections through the œsophageal region of a diglyphic polyp, the plane of division passing through one siphonoglyph.
- Fig. 5. Similar to fig. 4; division of the œsophagus completed.
- Fig. 6. Probably a diglyphic polyp originally, the plane of division having passed through both siphonoglyphs.
- Fig. 7. A colony of three individuals, sectioned through the œsophageal region of each individual.
- Fig. 8. Section through the œsophageal region of a dividing diglyphic polyp.
- Fig. 9. Oral surface-view of the angle between two polyps—*A* and *B*—formed by division; the lines indicate the bases of the mesenteries seen through the transparent wall.
- Fig. 10. A typical bud. *10a*, cross section of the parent above the bud (indicated at *B*); *10b*, cross section of the bud; *10c*, indicates diagrammatically the relation of the bud to the parent; both seen in profile.
- Fig. 11. Diglyphic polyp with bud. *11a* shows cross sections of the parent and bud. *D, D'*, directives of the parent; *d, d'*, directives of the bud; *c*, pair of complete mesenteries derived from an incomplete pair just above it in the parent. *11b*, looking through the mouth of the bud from within the œsophagus of the parent; *s, s*, siphonoglyph of parent; *r*, ridge dividing siphonoglyph *s* transversely into two portions; *e, e*, edges of a cut across the œsophagus of the parent to the mouth of the bud.
- Fig. 12. Colony of four individuals. *12a*, *A, I*, parent; *B*, bud on *A*; *C, D*, individuals formed by division of a second bud on *A*; *12b*, cross section of *A*, at the level of *xy*; *12c*, cross section of *C, D*; corresponding numbers indicate corresponding mesenteries in these two sections.



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PROCEEDINGS  
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THIRD SERIES.

ZOOLOGY.

VOL. I, No. II.

The Osteological Characters of the  
Genus *Sebastolobus*.

BY

EDWIN CHAPIN STARKS,  
*Biological Survey, Washington, D. C.*

WITH THREE PLATES.

*Issued December 22, 1898.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1898.



# THE OSTEOLOGICAL CHARACTERS OF THE GENUS SEBASTOLOBUS.

BY EDWIN CHAPIN STARKS.

*Biological Survey, Washington, D. C.*

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IN THIS paper the more important skeletal structures of the genus *Sebastolobus* are described somewhat in detail. This fullness in description is justified by the fact that the osteology of this genus has not hitherto been worked out and that its place among related genera has been determined chiefly from an examination of external characters.

The first part of the present paper is wholly descriptive in character, while in the second part an attempt has been made to point out the resemblances of this genus to the other members of the Scorpænidæ and other families of mail-cheeked fishes.

The species whose skeleton has been taken for study is *Sebastolobus alascanus* Bean. The specimen was about 9 inches long.

The plates illustrating this article are from drawings by Chloe Lesley Starks.

## A. DESCRIPTIVE.

## I.—THE SKULL.

## PLATE XXII, FIGS 1-3.

*The basioccipital (bo.)* forms the entire centrum of the condyle for the attachment of the vertebra. The suture separating it from the exoccipital runs longitudinally directly through the middle of the auditory capsule until it reaches a transverse suture at right angles to it, separating the basioccipital and exoccipital from the proötic.

*The exoccipitals (eo.)* alone border the foramen magnum, meeting slightly above it. Below it, a little within the mouth of the foramen between their articular facets, above the basioccipital, they meet as a bridge of bone.

*The supraoccipital (so.)* is interposed posteriorly between the exoccipitals, separating them except at their posterior upper corners. It extends anteriorly to the frontals, but is so covered by the parietals that only a small portion of it is visible.

*The parietals (p.)* extend laterally over the supraoccipital and meet in an irregular suture. Posteriorly they overlie and cover the upper portion of the epiotics. Each bears two large spines, the posterior of which is pierced at its base by a large transverse foramen.

*The epiotic (epo.)* is a pyramidal bone with a rather large articular surface for the articulation of the superior limb of the post-temporal which is strongly wedged in between it and the overhanging parietal.

*The pterotic (pto.)* forms the usual posterolateral wing of the skull. It bears a large spine on its upper surface, and to its under side is attached the posterior part of the head of the hyomandibular.

*The opisthotic (opo.)* is a scale-like bone overlying the suture between the pterotic and exoccipital on the lower aspect of the skull. The inferior limb of the post-temporal is attached to it.

*The myodome*, or chamber for the insertion of the rectus muscles of the eye, is partitioned off from the brain cavity by shelves of bone developed from the inner surfaces of the proötics, which meet medially and form the base of the brain cavity (*basis cranii*). The partition is continuous with the basioccipital, which is concave along its lower surface, leaving a tube between it and the parasphenoid. It opens to the exterior as a very small pore in a notch in the end of the parasphenoid.

*The basisphenoid* (*bs.*) articulates to the roof of the myodome by two lateral limbs, leaving a small space behind it. It extends forward and downward nearly to the parasphenoid as a thin paddle-shaped bone.

*The parasphenoid* (*pas.*) sends a brace upward from each side along the anterior edge of the proötic. It runs back as a splint-like bone nearly to the posterior end of the basioccipital.

*The frontals* (*fr.*) are tunnelled longitudinally for their whole length by large sensory canals.\* They bear three pairs of spines on their lateral edges.

Lying laterally to the frontals and the ethmoid is the *pre-frontal* (*pf.*), whose upper end projects upward as a spine.

In the *sphenotic* (*spo.*) is a continuation of the orbital sensory canal. On the lower surface is sunk a socket for the insertion of a projecting limb from the anterior part of the head of the hyomandibular.

*The proötic* (*pro.*), *alisphenoid* (*als.*), *ethmoid* (*e.*), and *vomer* (*v.*) are sufficiently shown in the drawings and need no description.

## II.—SUSPENSORIUM, MANDIBLE, AND OPERCULAR APPARATUS.

PLATE XXII, FIG. 4.

*The hyomandibular* (*hm.*) articulates with the sphenotic by a rounded process from its upper anterior edge, behind

---

\*Prof. C. W. Greene of Stanford University has protested to me against the use of the term "mucous canal." He has proved in many instances that, though they may be filled with mucous, their function is essentially that of sensory canals and they should be so called.

which its flat upper edge fits in a slight groove in the *ptero-tic*. Its lower end meets the long slender *symplectic* (*sy.*) which is ankylosed to the inner surface of the *quadrate* (*q.*). It ends anteriorly just behind the prominent articular process for the lower jaw.

The *metapterygoid* (*mpt.*) sends a flat, delicate lamina of bone from its inner surface upward to an anterior angle of the hyomandibular.

The *pterygoid* (*pt.*) is small, but a comparatively large *palatine* (*pa.*) makes up the otherwise deficiency in the length of the process formed by these two bones. Above them the large, thin *mesopterygoid* (*mspt.*) articulates.

On the posterior lower corner of the *articular* (*ar.*) the *angular* (*an.*) is developed as a triangular bone. The lower edge only of the articular is articulated to the *dentary* (*d.*), leaving a space between its upper edge and the superior backward projection of the dentary.

The *preoperculum* (*pop.*) at its upper end is sunk in a large groove in the hyomandibular. It is hollowed out by a sensory canal which is bridged over only at each of the five spines that are so characteristic on this bone in the Scorpænidæ.

The *operculum* (*op.*) is strengthened by two slight, radiating ridges, which end in flat spines posteriorly. Underlying its lower edge and turning up around its anterior edge for a short distance is the long, narrow *suboperculum* (*sop.*), which is only slightly ossified. The *interoperculum* (*iop.*) meets, but does not lap over, the suboperculum.

### III.—SHOULDER GIRDLE.

PLATE XXIII, FIGS. 5 AND 6.

The *hypercoracoid* (*hyc.*) is pierced by a very large foramen, above which its outer surface lies flat against, and is firmly articulated to, the *clavicle* (*cl.*).

The *actinosts* (*a.*) are rather large and hour-glass-shaped. Two and a half of them are articulated to the hypercoracoid,

and one and a half to the *hypocoracoid* (*hypc.*). About three of the upper rays of the pectoral articulate directly with the edge of the hypercoracoid.

*The postclavicle* (*pcl.*) is in two parts. The superior part is thin and laminate, the inferior ray-like.

*The post-temporal* (*pot.*) is widely forked. Through its base is a longitudinal sensory canal continuous with a similar one through a dermal bone between it and the skull. It bears a backward-projecting spine posteriorly.

#### IV.—VERTEBRAL COLUMN.

PLATE XXIII, FIG. 9; PLATE XXIV, FIG. 13.

Vertebral formula,  $11 + 17 + \text{Hypural} = 29$ .

The neural spine of the atlas is not coössified with the centrum. Its forks, where they meet the centrum, approach each other around the lower side of the neural canal and fit into slight sockets.

The first two neural spines point more nearly forward than do the rest, leaving a space between them and the third into which the first two interneurals fit.

The first two ribs articulate with the base of the neural spines of the first two vertebræ. The succeeding ones articulate gradually lower down, directly with the vertebræ, without the intervention of transverse processes, until at the sixth vertebra there is the first small transverse process at its lower side.

The first two ribs do not bear *epipleurals* (*cpp.*); only the succeeding four have them. The remaining epipleurals join the large transverse processes with the ribs.

The transverse processes, except the first or rudimentary pair, point straight down. The opposing processes are ankylosed for nearly their whole length. There is a hæmal arch left at their bases similar to that of the hæmal spines and their points are separate.

*The hypural* (*h.*) is assisted in bearing the caudal fin by the hæmal spine of the preceding vertebra, by four or five

loose accessory spines taking the place of the neural spine of that vertebra, and very slightly, by the hæmal and neural spines of the second preceding vertebra.

#### V.—ANAL AND DORSAL INTERSPINOUS RAYS.

PLATE XXIII, FIG. 10; PLATE XXIV, FIG. 11.

The first *interhæmal spine* (*ihs.*) of the anal fin is very large and, in cross-section, trilobate. It probably represents the ankylosed first two interhæmals, since to it are articulated the first two anal spines. The succeeding interhæmals are very small and weak.

The same condition is found in the first *interneural spine* (*ins.*), as it bears the first two dorsal spines. It is broad and triangular in outline, and the indications that it is the ankylosed first two elements are more evident.

#### VI.—HYOID APPARATUS.

PLATE XXIII, FIG. 8.

This arch is very typical and nothing need be mentioned except the *branchiostegal rays* (*brr.*). They are seven in number, five of them being articulated to the *ceratohyal* (*chy.*) and two to the *epihyal* (*cphy.*). The heads of the first three are not enlarged and are articulated to the lower edge of the ceratohyal, slightly more to the inner than to the outer side of that bone.

The other four rays have enlarged flattened heads which lie flat against the outer side of the cerato- and epihyals.

#### VII.—BRANCHIAL ARCHES.

PLATE XXIV, FIG. 15.

Two ossified and one cartilaginous *basibranchials* (*bbr.*) are present. The first is a short one to which the *hypo-branchials* (*hbr.*) of the first arch articulate. The second is long and its anterior end is notched to receive the hypo-



branchials of the second arch. The hypobranchials of the third arch are quadrangular in shape and their inner anterior corners touch each other. Their anterior sides lie against the posterior end of the long basibranchial of the second arch. Between their inner edges is interposed a triangular cartilaginous basibranchial, to which the *ceratobranchials* (*chr.*) of the fourth arch articulate, the hypobranchials of that arch being absent. The first arch bears a styliiform, toothless *pharyngobranchial* (*phbr.*) for the attachment of the arches to the base of the skull. Each of the other three arches bears a toothed pharyngobranchial, that of the third arch being the largest.

*The inferior pharyngeals* (*iph.*) meet at their inner edges but are not coössified.

#### VIII.—ORBITALS AND NASALS.

PLATE XXIV, FIG. 12; PLATE XXII, FIG. 1.

*The preorbital* (*por.*) and two *suborbitals* (*sor.*) are joined together by sutures and form the spinous ridge along the cheek to the preopercle. They appear as a single bone. For their whole length they are hollowed out by a sensory canal, which is bridged over only at long intervals. The posterior half of the second suborbital forms the suborbital stay. At about the middle of its upper edge the small chain of suborbitals extends up to the sphenotic. They appear to be irregular in number, as on the left side there are four and on the right only three.

*The nasals* (*na.*) are rather firmly articulated to the ethmoid. They bear spines and are pierced by foramina anteriorly.

#### B. COMPARATIVE.

The skeletons of *Sebastodes flavidus*, *Scorpaena guttata*, and *Sebastes marinus*, and the skulls for special points of *Sebastodes mystinus*, *Sebastodes carnatus*, and *Sebastodes*

*nebulosus* have been examined and compared with *Sebastolobus*. These as a group (Scorpænidæ) were compared with the Hexagrammidæ.

From the Cottidæ these two families are well separated osteologically, as pointed out by Dr. Gill.\*

The differences which that author found between the Hexagrammidæ and the Scorpænidæ, causing him to place the former family closer to the Cottidæ, were confirmed with these specimens, with the exception of the difference which he noted in the basisphenoid. This element was found with a well developed "descending process" in *Sebastolobus*, in *Scorpæna*, and in several examples of *Sebastodes*. In *Sebastes* it was as he describes it, but the process being so very fragile, with such a small peduncle it might easily have been broken off, leaving only the "triangular element" with no trace of any descending process.

The species of Hexagrammidæ examined were *Hexagrammos decagrammus* and *Zaniolepis latipinnis*. The skulls of the four genera of Scorpænidæ examined are strikingly similar in their characters.

The species of the genus *Sebastodes* vary nearly as much among themselves as do these genera.

The variation of the parietals in their relation to each other in *Sebastodes* has been several times pointed out by different authors in attempts to divide the genus. In *Sebastolobus alascanus* and *Scorpæna guttata* they meet over the supraoccipital. In *Sebastes marinus* they do not.

A difference in *Sebastolobus* was thought to have been found in the lack of any posterior opening to the myodome. A careful search with a lens and bristle, however, revealed an exceedingly small one. In the other three genera this opening is well developed.

The nodule on the front of the prefrontal for the articulation of the palatine, which is so well developed in *Sebastodes* and *Sebastes*, appears to be absent in *Sebastolobus* and but slightly developed in *Scorpæna*.

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\*On the classification of the Mail-cheeked Fishes, Proc. U. S. Nat. Mus., 1888.

The parietals of *Sebastes* and *Sebastodes* do not so overlap the epiotic that the superior fork of the post-temporal is wedged in between them, as is the condition in *Sebastolobus* and *Scorpena*.

COMPARATIVE VERTEBRAL FORMULA.

SPECIES.	Trunk Ver.	Tail Ver.	Hypural Ver.	Total.
<i>Scorpena guttata</i> .....	9	14	1	24
<i>Sebastodes flavidus</i> .....	11	14	1	26
<i>Sebastolobus alascanus</i> .....	11	17	1	29
<i>Sebastes marinus</i> .....	12	17	1	30

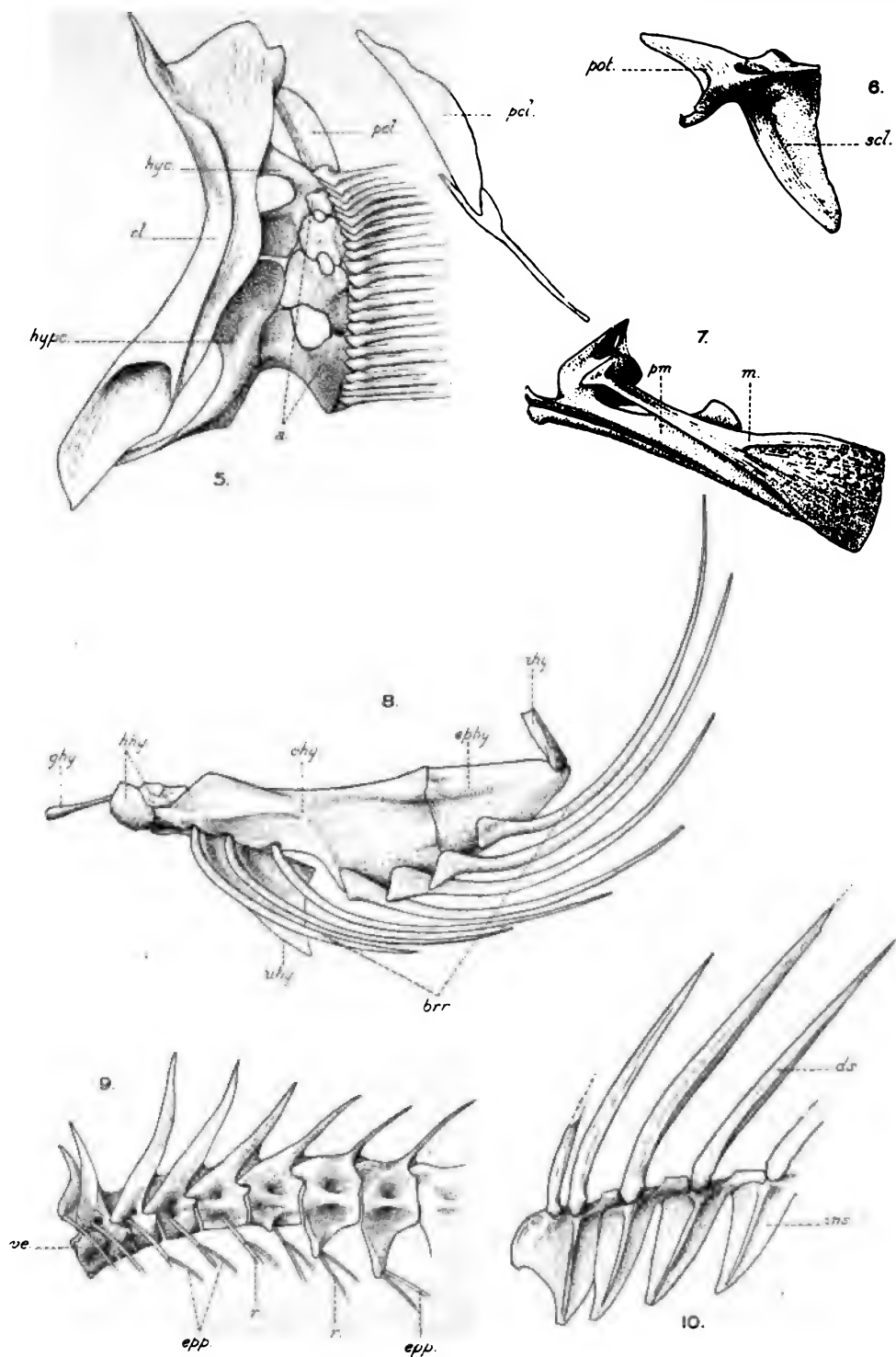
The transverse processes are not developed very far forward in any of the group. In *Sebastolobus* the first rudimentary one is on the sixth vertebra; on the seventh in *Sebastes*; on the fifth in *Sebastodes*; and in *Scorpena*, which has the fewest abdominal vertebræ of the four, it is on the sixth. In this genus there are only three well developed transverse processes.

The transverse processes of *Sebastolobus* have been described as pointing downward and each pair being fused for nearly its whole length. This condition is shared by *Scorpena*. *Sebastes* and *Sebastodes* differ from them in having the processes widely diverging, pointing outward and downward. There is a slight bridge of bone connecting each pair at their bases, however, so this can probably only be regarded as a difference in degree. The ankylosed condition of the first two interneurals and the first two interhæmals, as described for *Sebastolobus*, is the same in the other three genera.

## SIGNIFICANCE OF REFERENCE LETTERS.

(Drawings all on the same scale used in fig. 1.)

a.	— actinosts.	m.	— maxillary.
als.	— alisphenoid.	mpt.	— metapterygoid.
an.	— angular.	mspt.	— mesopterygoid.
ar.	— articular.	na.	— nasal.
as.	— anal spines.	op.	— operculum.
bbr.	— basibranchials.	opo.	— opisthotic.
bo.	— basioccipital.	p.	— parietal.
brr.	— branchiostegal rays.	pa.	— palatine.
bs.	— basisphenoid.	pas.	— parasphenoid.
cbr.	— ceratobranchials.	pcl.	— postclavicle.
chy.	— ceratohyal.	pf.	— prefrontal.
cl.	— clavicle.	pg.	— pelvic girdle.
d.	— dentary.	phbr.	— pharyngo-branchials.
ds.	— dorsal spines.	pm.	— premaxillary.
e.	— ethmoid.	pop.	— preoperculum.
ebr.	— epibranchials.	por.	— preorbital.
eo.	— exoccipital.	pot.	— post-temporal.
ephy.	— epihyal.	pro.	— proötic.
epo.	— epiotic.	pto.	— pterotic.
epp.	— epipleural.	pt.	— pterygoid.
fr.	— frontal.	q.	— quadrate.
ghy.	— glossohyal.	r.	— ribs.
h.	— hypural.	scl.	— supraclavicle.
hbr.	— hypobranchials.	so.	— supraoccipital.
hhy.	— hypohyal.	sop.	— suboperculum.
hm.	— hyomandibular.	sor.	— suborbital.
hyc.	— hypercoracoid.	spo.	— sphenotic.
hypo.	— hypocoracoid.	sy.	— symplectic.
ihs.	— interhæmal spines.	uhy.	— urohyal.
ihy.	— interhyal.	v.	— vomer.
ins.	— interneural spines.	ve.	— vertebrae.
iop.	— interoperculum.	vf.	— ventral fin.
iph.	— inferior pharyngeals.		



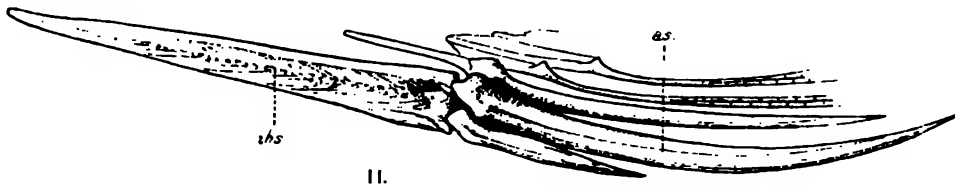
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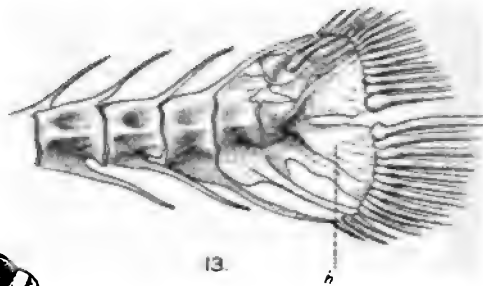




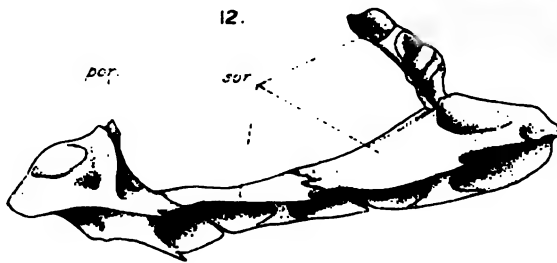




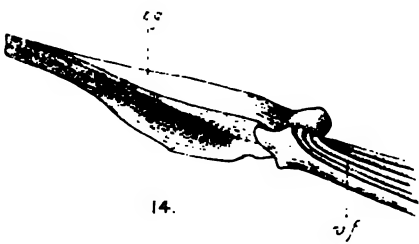
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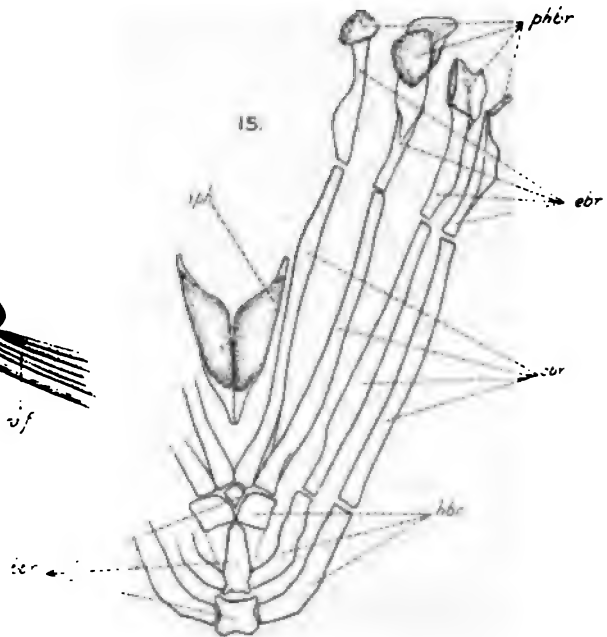
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PROCEEDINGS  
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THIRD SERIES.

ZOOLOGY.

VOL. I, No. 12.

Odonata from Tepic, Mexico, with Sup-  
plementary Notes on those of  
Baja California.

BY

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*Instructor in Zoology, University of Pennsylvania.*

WITH ONE PLATE.

*Issued May 22, 1899.*

SAN FRANCISCO:  
PUBLISHED BY THE ACADEMY.  
1899.

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# ODONATA FROM TEPIC, MEXICO, WITH SUPPLEMENTARY NOTES ON THOSE OF BAJA CALIFORNIA.

BY PHILIP P. CALVERT, PH.D.,

*Instructor in Zoology, University of Pennsylvania.*

## PLATE XXV.

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PART II.	SUPPLEMENTARY NOTES ON THE ODONATA OF BAJA CALIFORNIA.....	408
PART III.	NOTES ON SOME OF THE INTERNAL ORGANS.....	410
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### INTRODUCTION.

A REPORT on the Odonata of Baja California, collected by the various expeditions of the Academy, was published by the author in a former paper.<sup>1</sup> With the last installment of material from that region was also sent a collection from the West Mexican coast, made by Dr. Gustav Eisen and (the late) Mr. Frank H. Vaslit, in October and November, 1894. It consists of 526 specimens (294 males, 232 females) representing 42 species and varieties. Of these, five species are new—*Argia Harknessi*, *Brechmorhoga postlobata*, *Macrothemis inacuta*, *Trithemis Montezuma* and *Anatya normalis*; two species, *Argia pulla* and *Æschna macromia*, have not previously been known north of South America, *Anax amazili* not farther north than Guatemala, and *Lestes tenuatus* from no other localities than the Antilles. The insects were placed in alcohol and as their colors were thus

<sup>1</sup> Proc. Cal. Acad. Sci., 2nd Ser., Vol. IV, 1893-94, pp. 463-556, Pls. XV-XVII.

beautifully preserved, as remarked in the paper on the Baja Californian Odonata, I have redescribed a number of species which seemed insufficiently known.

As to the localities from which they were brought, Dr. Eisen wrote, "The specimens from Tepic are mostly from an altitude of 3400 feet. I succeeded in getting specimens of all the different species of dragonflies which I saw." Much praise is due to Dr. Eisen and Mr. Vaslit for the results of their efforts.

The considerable interval which has elapsed since the Tepic collection was sent to me for study is mainly due to absence in Europe, which, however, gave me the opportunity to compare some of the specimens with those in the principal museums, and of making some additions and corrections to the paper on the Odonata of Baja California, which, so far as they do not also concern the species from Tepic, forms Part II of the present article. Dr. Eisen's "Explorations in the Cape Region of Baja California in 1894, With References to Former Expeditions of the California Academy of Sciences"<sup>1</sup> gives much information respecting localities which I did not possess when writing. From his maps it appears that the San Raymundo at which Mr. Haines collected some Odonata<sup>2</sup> is located at  $26^{\circ} +^{\circ}$  N.,  $112^{\circ} +^{\circ}$  W., and San Ignacio at  $27^{\circ} +^{\circ}$  N.,  $113^{\circ} +^{\circ}$  W.

Lastly, I have given some results of examinations of the internal organs of various species in Part III.

## I. ODONATA FROM TEPIC, MEXICO.

### Subfamily CALOPTERYGINÆ.

#### 1. *Hetærina americana Fabricius*.

*Agrion americana* FABR., Ent. Syst. Suppl., 1798, p. 287.

*Hetærina americana* SELYS, Monog. Calopt., p. 131, Pl. XII, fig. 3, 1854;

HAGEN, Proc. Bost. Soc. Nat. Hist., Vol. XVIII, 1875, p. 23; KIRBY, Cat. Odon., 1890, p. 106; CALVERT, Trans. Am. Ent. Soc., Vol. XX, 1893, p. 228.

<sup>1</sup> Proc. Cal. Acad. Sci., 2nd Ser., Vol. V, 1895, pp. 733-775, 4 maps.

<sup>2</sup> Former paper l. c., p. 464.

*Males.* These have the superior appendages similar to those of specimens from Texas in the collection of the Academy of Natural Sciences of Philadelphia, although not agreeing with Walsh's description of the form he named *H. texana*,<sup>1</sup> since the "large laminiform medial tooth" does not appear bilobate.

The chief differences from the typical form of *americana* as described in the Monographie des Calopterygines are, for the males:—

The superior appendages have the distal tubercle of the inner margin ("dent très-petite et arrondie") more acutely pointed, but there is considerable individual variation in this respect.

The red at the base of the front wings extends along the costa one-half to two-thirds of the distance to the nodus; the outer (distal) edge of the red coloring is convex, so that the farthest point from the base of the wing which it attains is between the median and the short sectors and slightly more than three-fourths the distance from the base of the wing to the nodus, while it attains the hind margin of the wing at about the same level as its point of separation from the costal margin.

The color at the base of the hind wings is also red, but with an admixture of brown, especially near the anterior margin of the wing; it extends along the costa from the base to almost three-fourths the distance to the nodus, the outer (distal) edge is nearly straight and extends backward and somewhat inward (mesad) from the costa to within one cell of the hind margin of the wing, where it turns basalward and gradually approaches the hind margin of the wing, reaching it in from six to eight cells, or at about the level of the distal end of the quadrilateral.

The pterostigma varies from light brown to black.

The yellow humeral and first lateral thoracic stripes are interrupted or may almost entirely disappear.

The metallic coloring, especially on the thorax, tends to purplish, but this may be the effect of the alcohol in which the specimens were preserved.

*Female.* In the females the extent of the brownish yellow coloring at the base of the wings is difficult to define, owing to its gradually fading into yellow, the pterostigma is always yellow, the humeral and first lateral thoracic stripes are never interrupted, the mid-dorsal carina is never yellow, the metallic color in the majority of individuals is green.

*Dimensions:* Abdomen, ♂ 32-34 mm., ♀ 28-30 mm.; hind wing, ♂ 24-25.5 mm., ♀ 25-26 mm.

20 ♂	18 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
22 ♂	4 ♀	" Nov., 1894, " " "
3 ♂	10 ♀	No locality or date.

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45 ♂	32 ♀
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<sup>1</sup> Proc. Ent. Soc. Phila., Vol. II, 1863, p. 227.

## Subfamily AGRIONINÆ.

2. *Archilestes grandis* Rambur.

*Lestes grandis* RAMB., INS. NEVT., 1842, p. 244.

*Archilestes grandis* CALVERT, Proc. Cal. Acad. Sci., 2nd Ser., Vol. IV, 1893-94, p. 475, Pl. XV, figs. 10 and 11.

The male taken in November has the terminus of the dilated part of the middle of the superior appendages a well-defined tooth.

2 ♂	1 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
1 ♂	1 ♀	Nov., 1894, " " "
3 ♂	2 ♀	

Since the publication of my report on the Baja Californian Odonata cited above, Mr. McLachlan has published<sup>1</sup> the description of another *Archilestes*, *A. californica*, based on one adult male from "California" by Henry Edwards. This has led to some correspondence between us on the question of the relationship of the Baja Californian specimens, which I referred to *grandis*, and *californica*. Having sent a pair of the former to Mr. McLachlan, he has compared them with his type and also with his series of *grandis*. By his kind permission I present his results here:

"Your letter \* \* \* has induced me to look into my long series of *grandis* from Texas, interior of Mainland of Mexico, Costa Rica, and Venezuela. I take first your Baja Californian examples. There can, I think, be no doubt that these form a local race of *grandis*. I find great variability in the latter, and the Venezuelan examples in my collection seem worthy of a racial name. In these the thorax is almost wholly bronzy black, there being only the sutural indications of a pale humeral line, and two very narrow, yellow, lateral lines, the dark color practically invading the whole.

"With regard to my type of *A. californica*, I think I must regard it also as a race of *grandis*. But unless it be an exceedingly teneral individual it is a race of a very marked character. As an argument against its being teneral there is the fact that pruinosity has distinctly commenced. The ground-color of the insect is distinctly *pale brown, ochreous brown or grayish brown (not yellow)*, and the entire abdomen may be said to be pale brown (darker after the sixth segment). With respect to the appendages (♂), the inferiors strike me as *blunter* than in typical examples [of *grandis*], but this is not trustworthy from a single specimen. That the color largely influenced me in

<sup>1</sup> Ann. Mag. Nat. Hist., 6th Ser., Vol. XVI, 1895, p. 20.



considering it a distinct species is undoubted; I think the point of departure of the nodal sector is very variable in *grandis*, some Venezuelan specimens on this character only would almost fall into *Lestes* (restricted).

"To sum up on the point that intimately concerns you. I am strongly of opinion that unless my example be very teneral (and I don't think it is teneral) it cannot be of the same race as your Baja Californian examples, and I don't think it would be advisable to unite the latter therewith unless with a strong mark of doubt, pending possibility of obtaining more materials for the true *californica*. It is unfortunate there is no special locality for this latter, but I don't think H. Edwards collected beyond the limits of the State of California (I mean southward).

"I might put the color matter more concisely, taking my original description in conjunction with your nomenclature. The only blackish color is as follows: The two cuneate spots on top of head; the prothorax in part; the two broad antehumeral bands, one on each side, which are very sharply circumscribed and scarcely reach the edge of the thorax at either end; the isolated mesepimeral spot. All the rest of the thorax and abdomen is pale brown, and whether the individual be teneral or not, I think it is beyond the bounds of possibility that any further development of bronzy or blackish color could take place. Therefore the differences between it and your Baja Californian examples are infinitely greater than between these latter and typical *grandis*."

It seems advisable to place on record here some notes on the Baja Californian specimens made subsequent to the publication of my report and based on considerably less than the whole number of individuals therein cited.

The antehumeral stripe is in the males nearly two-thirds, in the females and one male one-half, as wide as the distance between the mid-dorsal and humeral sutures and its color varies from dark metallic brown, almost black, to dark metallic green. There is a mesepimeral stripe, of nearly equal width with the antehumeral stripe and of similar hue, which is followed by a yellowish area less bright than in more typical *grandis*. The abdomen is of a very dark, almost black, color but has a metallic green reflection. Pterostigma dark brown, surmounting two and one-half to three and one-half cells. Median vein and costa externally not yellowish but blackish, like the rest of the reticulation; 11-15 postnodals on the front wings, 11-13 on the hind.

*Dimensions:* Abdomen, ♂ 41-45 mm., ♀ 36-37 mm.; hind wing, ♂ 30-33 mm., ♀ 32 mm.<sup>1</sup>

<sup>1</sup> Shortly before receiving the proof of this paper, Prof. C. V. Piper sent me a male *Archilestes* from Yakima, Washington, Sept., 1894. Its abdomen is 36.5 mm. long. Its hind wing 28 mm. Pterostigma 3.5 mm., pale reddish brown, surmounting one long cell and parts of one or two other smaller ones. Antehumeral stripes at their middle one-half as wide as the distance from mid-dorsal carina to humeral suture, reaching from antealar sinus almost to anterior mesothoracic margin, blackish with a slight metallic green reflection. A mesepimeral spot of similar color, subequal width and about one-half as long as the antehumeral stripe; below this spot the color is yellowish, but not bright. Pruinosity has appeared on the thorax and base of the abdomen. The appendages agree with my fig. 10, Pl. XV, l. c. In other respects this male agrees with the Baja Californians described above, although its size is nearly that of *A. californica*.

3. *Lestes tenuatus Rambur.*

PLATE XXV, FIG. 3.

*Lestes tenuata* RAMB., Ins. Nevr., 1842, p. 245; SELYS in Sagra Hist. Cuba, Ins., 1857, p. 463; Bull. Acad. Belg., 2d Ser., Tome XIII, 1862, p. 315; HAGEN, Syn. Neur. N. Am., 1861, p. 69; Proc. Bost. Soc. Nat. Hist., Vol. XI, 1867, p. 289.

*Lestes tenuatus* KIRBY, Cat. Odon., 1890, p. 162.

As these are probably fresher specimens than those previously available for description, the following is given:

*Male* (young). Pale ochre-brown except where different colors are expressly stated, viz.: labrum perhaps light blue in some in life; between each antenna and the adjoining eye a nearly semicircular, dark metallic green spot; vertex blackish or dark metallic green; on either side of the thoracic dorsum a narrow, well defined green stripe extending from the anterior mesothoracic margin almost to the antealar sinus, its width slightly greater than the distance separating its inner (mesal) margin from the mid-dorsal thoracic carina; a very ill defined and much paler metallic green stripe on the mesepimeron; between these two (ante- and posthumeral) stripes, and a considerable part of the sides of the thorax, probably pale blue in life, with the pectus and the sutures yellowish; a small dark brown spot near the anterior end of the latero-ventral metathoracic carina; abdominal segments yellow underneath, 1-8 or 10 with a pale metallic green reflection above, but paler, when present, on 9 and 10; a narrow, transverse, pale yellow basal ring on 3-7 or 8; an ill defined, transverse, apical fuscous band on 3-8.

Superior appendages as long as 9, forcipate, yellowish at base, sometimes fuscous at tip, outer, upper edge with seven to eight acute denticles, inner, lower margin with a fairly stout basal tooth which is truncated in a straight line parallel with the outer edge of the appendage; beyond this tooth the inner margin of the appendage viewed from above is somewhat dilated and bears a row of acute, slender denticles, terminating at a constriction of the appendage about one-sixth of its length before the apex; viewed from the side the basal tooth has an obtuse conical form, the terminal third of the appendage is directed slightly downwards, the dilatation of the inner margin and subsequent constriction are not visible and the extreme apex is blunt.

Inferior appendages<sup>1</sup> half as long as the superiors, reaching beyond the

<sup>1</sup> In the Transactions of the Amer. Ent. Soc., Vol. XX, 1893, pp. 198, 199, I pointed out that the "inferior appendages" of the males of the Zygoptera and Anisoptera are not homologous, and briefly described their development, and that of the superior appendages, from the structures of the nymph. These statements have been confirmed by the recent valuable and important researches of Heymons (Anhang Abhand. Königl. preuss. Akad. Wiss. Berlin, 1896) from the embryological standpoint. His remarks (l. c., p. 43) suggest the inappropriateness of employing the same name for structures which (morphologically, although not physiologically) "nichts mit einander zu thun haben." (Compare figs. 3 and 5, Pl. XXV, accompanying the present paper.) I have not adopted his terms, however, since one of them at least (appendix dorsalis for the "inferior appendage" of Anisopterous males) is anatomically inappropriate when applied to the imago, although quite fitting in the nymph. I have continued, therefore, to use the old terms of the systematists. Perhaps it will be best to select names for these various "processes" and "appendages" which shall, by their etymology, indicate the segments to which they belong, rather than their positions as dorsal, lateral, superior, inferior.

basal tooth but not as far as the denticulated dilatation; yellowish or luteous, darker at the tip; much narrower in the apical half (in that midway on the inner side there is a distinct "shoulder" where the narrowing begins) and curved somewhat inwards, apex blunt and rounded.

Femora with two blackish stripes, one anterior, the other inferior; tibiae with a single inferior blackish stripe.

Wings clear, pterostigma fusco-luteous, surmounting two cells; front wings with ten to thirteen postnodals, nodal sector arising usually between the third and fourth (between fourth and fifth in one wing of one male); hind wings with ten to eleven postnodals, nodal sector arising usually, but not always, close to the third.

*Female* (young). Like the male in coloring. Abdominal segment 10 not metallic green but pale yellowish in most individuals, its hind margin with a median excision whose depth is one-fifth of the length of the segment, appendages as long as 10. Margins of the genital valves denticulated, their slender processes extending backwards as far as do the appendages of the 10th segment.

*Dimensions:* Total length, ♂ 46 mm., ♀ 42–44 mm.; abdomen, ♂ 38 mm., ♀ 33.5–35 mm.; hind wing, ♂ 23.5 mm., ♀ 23.5–25 mm.

5 ♂ 14 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

1 ♂ " Nov., 1894, " " "

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6 ♂ 14 ♀

*Tenuatus* has hitherto been recorded only from the islands of Cuba and Martinique. Some years ago I identified a female from Bath, Jamaica, by Mrs. Swainson, sent me by Mr. T. D. A. Cockerell.

#### 4. *Mecistogaster ornatus* Rambur.

*Mecistogaster ornatus* RAMB., Ins. Nevr., 1842, p. 288; KIRBY, Cat. Odon. 1890, p. 120.

The opaque yellow spot at the tip of the wings stops inferiorly at the ultranodal sector, the pale yellow "milky" spot below extends to the nodal sector. Abdomen 88–93 mm., hind wing 57.5–60 mm. De Selys' statement for the genus *Mecistogaster*, "quadrilatère à côté supérieur un quart on un tiers plus court que l'inférieur"<sup>1</sup> holds for only the hind wings of these two males; on the front wings the upper

<sup>1</sup> Mém. Couron., Acad. Belg., Vol. XXXVIII, 1886, p. 15.

side is but one-half (or less) as long as the lower side. Dr. Eisen writes of this species, "It lives entirely in the shadow and is very rare."

Six specimens (teste Dr. Eisen, I have seen but two males), Baranca Blanca, 2400 ft., near Tepic, Nov., 1894, Eisen and Vaslit.

The Museum of Comparative Zoology at Cambridge, Massachusetts, contains individuals of this species from the following unrecorded localities: Polyon, Department Occidentale, Nicaragua (McNeill Coll.); Isthmus of Tehuantepec (F. Sumichrast), Acapulco, Mexico (A. Agassiz).

### 5. *Argia Harknessi*, sp. nov.

#### PLATE XXV, FIG. 6.

*Male* bluish violet with the following black markings: the posterior surface of the second antennal joint and all of the following joints; a transverse vertical band from eye to eye, confluent at the occiput with black covering most of the rear of the head—a pair of cuneiform, violet, postocular spots consequently exist; a mid-dorsal prothoracic and thoracic band, enclosing a small circular violet spot on the hind lobe of the prothorax; a humeral stripe as wide at its lower end as the mid-dorsal, narrowed at right angles in its lower fourth to half the width of the mid-dorsal, reduced to a line in its upper half—the violet which remains between the mid-dorsal band and the humeral stripe is throughout wider than the former; a line at the upper end of the obsolete first lateral thoracic suture, a complete line on the second lateral suture; a mid-dorsal and a lateral spot on abdominal segment 1; on 2 a superior longitudinal cuneiform stripe (the apical end the wider) and an inferior longitudinal stripe each side, and a transverse apical ring; 3-5 with a lateral apical stripe, pointed anteriorly, and reaching half-way to the base, uniting on the mid-dorsal line with its fellow of the opposite side in the apical third of the segment; similar stripes on 6 but occupying more than the apical half of the segment; 7 almost entirely black except for a narrow, transverse, basal, violet ring; inferior lateral longitudinal stripes on the apical part of 8 and for the whole length of 9 and 10; a narrow, transverse, basal ring and a similar apical ring on 10 uniting with the lateral stripes; sterna of 3-10; femora superiorly, tibiae inferiorly, tarsi entirely.

Tenth abdominal segment on its apical margin with a mid-dorsal, semicircular excision having a pale tubercle on either side and a pale median tubercle below.<sup>1</sup>

<sup>1</sup> Such a median tubercle is mentioned by Hagen (Syn. Neur. N. Am., p. 90, 1861) for *A. bipunctulata*, and is to be found in many Agrionine males. It is probably homologous with *app. d.*, fig. 3, Pl. XXV, accompanying this paper, and with the "inferior appendage" of adult Anisopterous males.

Appendages blackish. Superiors a little more than half as long as 10; viewed from above, divergent, each with outer and inner sides nearly parallel, apex bifid, branches subequal and parallel; viewed in profile, directed slightly downwards, with an inferior basal tubercle. Inferiors longer than the superiors, about as long as 10; viewed in profile they are directed upwards, upper margin nearly straight, lower somewhat concave, apex truncated nearly at right angles to the long axis of the body, but from the middle of the truncated margin projects a triangular process directed backwards and somewhat upwards.

Wings clear. Pterostigma dark brown, surmounting one cell, outer end more oblique than the inner. Front wings with five antenodal cells, sixteen to seventeen postcubitals, nodal sector arising near the seventh or eighth, ultranodal at two to four and one-half cells more remote, upper side of quadrilateral one-third as long as the lower side. Hind wings with four (five in one wing of one male) antenodal cells, thirteen to fourteen postcubitals, nodal sector arising near the sixth or seventh, ultra-nodal at three to five cells more remote, upper side of the quadrilateral one-half as long as the lower side.

*Female* (apparently of the same species) differs from the male in having the violet replaced by light blue throughout; occiput and most of the rear of the head pale, the latter with an irregular black spot on each side; lateral longitudinal stripes on 2-6 reaching almost the entire length of the segments; 8 and 9 with a second longitudinal stripe on each side, nearer the mid-dorsal line, united at the base on 8; the transverse apical ring and the lateral stripe on 10 lacking; 10 with a triangular, mid-dorsal, apical excision, with a pale bifid tubercle below; appendages pale, shorter than 10. Valvules pale, apical half of their ventral margins finely denticulated. Pterostigma ochreous, on the hind wings surmounting two cells.

*Dimensions:* Total length, ♂ 41-43 mm., ♀ 40 mm.; abdomen, ♂ 32-34 mm., ♀ 31 mm.; hind wing, ♂ 23.5-25 mm., ♀ 26 mm.

1 ♂	1 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
4 ♂		" Nov., 1894, " " "
<hr/>		
5 ♂	1 ♀	

The specific name is in honor of Dr. H. W. Harkness, past President of the California Academy of Sciences, to whom much of the success attending the expeditions to Baja California and to Tepic is due. Its nearest ally is probably *A. insipida* Hagen, the type of which I have studied in the Museum of Comparative Zoology, Cambridge, Mass., and from which it differs structurally and in the coloring.

6. *Argia extranea* Hagen.

PLATE XXV, FIG. 8.

*Argion extraneum* HAGEN, Syn. Neur. N. Am., 1861, p. 92; KIRBY, Cat. Odon., 1890, p. 138.

*Male* bluish violet with the following black markings: hind surface of second antennal joint and all of the following joints, a transverse vertex band from eye to eye, and a narrower curved stripe on the rear of the head, below which stripe the color is blue rather than violet; a mid-dorsal prothoracic and thoracic band; a humeral stripe as wide at its lower end as the mid-dorsal, abruptly narrowed at a right angle in its second fourth to half this width, contracted to a mere line at its middle and becoming only slightly wider at its upper extremity—the violet between the mid-dorsal and the humeral stripes is wider than the former; a narrow stripe on the second lateral suture; some lines in the grooves on the pectus; abdominal segment 1 at base; on 2 a longitudinal band each side, wider in its apical half, bilobed at apex, inner (mesal) lobe curved towards its fellow of the opposite side, and a narrow, transverse, apical ring; 3-6 with a longitudinal band each side, reduced to a line in the middle, much wider at the apices of the segments where, on 4-6, it unites with its fellow of the opposite side; 7 almost completely black, leaving only a narrow, transverse, basal ring and a mid-dorsal prolongation therefrom to about one-third of the length of the segment violet; 8-10 with an inferior longitudinal stripe each side for their entire length; sterna of 3-10; femora except at base, tibiae inferiorly, tarsi entirely.

Tenth abdominal segment with a mid-dorsal apical cleft, tuberculated on either side.

Appendages blackish. Superiors half as long as 10; viewed from above, apex wider than base and truncated in a straight line nearly at right angles to the long axis of the body; horizontal width of the apex greater than its vertical height; in profile they show an inner, apical tubercle. Inferiors nearly two and a half times as long as the superiors, a little longer than 10, extending backwards in the prolongation of the body, with the apex gradually tapering but not acute; viewed in profile each shows on its upper surface a median, conical, pointed tubercle just distal to the apex of the superiors, while the lower edge is concave.

Wings clear. Pterostigma dark brown, surmounting more than one but less than two cells, outer end convex, inner straight. Front wings with four antenodal cells, fourteen to sixteen postcubitals, nodal sector arising at or near the seventh, ultra-nodal at two or three cells more remote. Hind wings with three antenodal cells, 12 postcubitals, nodal sector arising at or near the sixth, the ultra-nodal at three cells more remote.

*Dimensions:* Total length 35-36 mm.; abdomen 28-29 mm.; hind wing 21.5 mm.

2 ♂ Tepic, Oct., 1894, Eisen and Vaslit.

7. *Argia fissa* Selys.

PLATE XXV, FIG. 11.

*Argia fissa* SELYS, Bull. Acad. Belg., 2nd Ser., Tome XX, 1865, p. 401;  
KIRBY, Cat. Odon., 1890, p. 138.

*Male* pale blue with the following black markings: antennæ beyond the second joint; a broken line enclosing an area corresponding to that of the postocular spots of many species; a C-shaped mark, with the convexity towards the median line, on either side of the middle prothoracic lobe, the ends of the C connected with a narrow black margin to this lobe; two dorsal spots on the hind prothoracic lobe; a mid-dorsal thoracic band; a humeral stripe, at its lower end nearly as wide as the mid-dorsal, in its lower half one-fourth to one-fifth as wide, still narrower in its upper half—the blue remaining between the mid-dorsal band and the humeral stripe is somewhat narrower than the former; a line on the second lateral thoracic suture; a small basal spot on abdominal segment 1; on 2 a longitudinal stripe, on either side, which at its apical end is bent at right angles and directed towards, but does not reach, the mid-dorsal line, and a transverse, apical ring; a triangular spot on either side of apex of 3-6, and a transverse apical ring which on 4-6 unites with these spots; a similarly united ring and pair of stripes on 7, each stripe prolonged on its side of the segment to the base; sterna of 3-10; femora superiorly, tibiæ inferiorly, tarsi entirely.

Abdominal segment 10 with a mid-dorsal, apical, quadrangular excision, as wide as deep, with a pale tubercle on either side. Appendages a little more than half as long as 10, pale. Superiors, viewed from above, divergent, apex somewhat blunt, outer side convex, inner side nearly straight; viewed in profile, each is directed but slightly downwards, upper margin more oblique than the lower, inner, lower margin with a small, pointed black tooth directed downwards. Inferiors equal in length to the superiors; viewed in profile, directed upwards, upper margin nearly straight with a slight triangular excision near the base, lower margin first convex then concave, apex truncated almost perpendicularly, produced as a slight tubercle at its lower angle; viewed from below, the two inferiors are straight, parallel, of nearly equal width throughout, apex truncated nearly at right angles to the long axis of the body, lower surface blackish.

Wings with a slight yellowish tinge. Pterostigma brown, surmounting a little more than one cell. Front wings with five antenodal cells, fifteen to seventeen postcubitals, nodal sector arising near the seventh or eighth, ultranodal at three or four cells more remote, upper side of the quadrilateral one-fourth as long as the lower side. Hind wings with four antenodal cells, thirteen to fifteen postcubitals, nodal sector arising near the sixth or seventh, ultranodal at two to three cells more remote, upper side of quadrilateral two-fifths as long as the lower side.

*Dimensions:* Total length 42 mm.; abdomen 33 mm.; hind wing 25 mm.

2 ♂ Tepic, Oct., 1894, Eisen and Vaslit.

I compared these two males with specimens from Guatemala in Baron de Selys' collection, with which they agree.

8. *Argia pulla* Selys.

PLATE XXV, FIG. 4.

*Argia pulla* SELYS, Bull. Acad. Belg., 2nd Ser., Tome XX, 1865, p. 410;  
KIRBY, Cat. Odon., 1890, p. 139.

The following description is based on 19 males and 9 females of the first of the lots mentioned below:—

*Male* violaceous with the following markings very dark metallic green or black: a transverse stripe across the top of the head from eye to eye, filling the space between the three ocelli; posterior face of second antennal joint and the whole of the following joints; often a line on the fronto-clypeal and on the clypeo-labral sutures; greater part of the rear of the head, except for a narrow stripe along the edges of the eyes inferiorly and a circular area around the posterior foramen; a mid-dorsal band on the middle and the hind prothoracic lobes and a narrow marginal stripe on the middle prothoracic lobe; a mid-dorsal thoracic and an almost equally wide humeral band, the former being equal in width at its lower end to the mid-dorsal prothoracic band, but is narrower above; the humeral band encloses a violaceous spot at its upper end and then fills the area between the humeral and first lateral sutures, or it is narrowed to the humeral suture at its upper end and encloses no spot—the violaceous color which remains between the mid-dorsal and the humeral bands is equal in width to the latter; a complete line on the second lateral suture and marks in the grooves on the pectus; basal half of abdominal segment 1; on 2 a longitudinal band each side, curved towards its fellow near the apex of the segment; greater part of 3-7, except a narrow, transverse, basal ring, and inferiorly on each side a longitudinal pale streak confluent with this ring; an apical longitudinal band each side of 8, sides of 10 entirely, 9 usually like 10 but in some as 8; sterna of 3-10; the legs, except the coxæ and the tibiae superiorly.

In young males the violaceous color is not yet developed, but is preceded by pale blue, and the dark markings are less extended, the legs pale, femora with two superior dark stripes.

Superior appendages pale, shorter than 10, directed outwards and downwards (in fig. 4 the superior appendage has been pushed up to show the inferior appendage more clearly), apex bifid; above each superior appendage is a large pale tubercle. Inferiors darker, longer, and larger than the superiors, but not quite as long as 10; viewed in profile each is directed slightly upwards and ends in three tubercles of which the most dorsal is received between the two tips of the bifid superior appendage of the same side, while the other two tubercles form the apex of the appendage, the inner ventral being the largest and broadest of the three and often minutely denticulated.

Wings with a very slight yellowish tinge. Pterostigma dark brown, surmounting very slightly less than one cell. Three antenodal cells. Front wings with twelve to fifteen postcubitals, nodal sector arising from the sixth to between the seventh and eighth. Hind wings with ten to thirteen postcubitals, nodal sector arising at the fifth or sixth (at the seventh in one wing of one male).



*Female* differs from the male in that the violaceous color is replaced by a pale cream color which in various individuals is faintly tinged with green or violaceous. Dark markings as in the male, but more limited in extent, the area between the ocelli and the rear of the head being chiefly pale colored, the humeral stripe cleft in its upper half, a short black line at the upper end of the first lateral thoracic suture, a pale mid-dorsal line on 3 and 4, 8-10, which are perhaps pale blue in life, have no dark markings in the young; one female has the two dark longitudinal bands on 2 united in front of the apex of the segment. Abdominal segment 10 with a deep, narrow, apical, dorsal cleft reaching almost to base. Appendages and valvules pale, the former shorter than 10. Legs pale, two superior dark stripes on the femora, first tibiae with an anterior stripe and most of the tarsi dark. Wings more yellowish than in the male, often brownish.

*Dimensions:* Total length, ♂ 30-33 mm., ♀ 32.5-35 mm.; abdomen, ♂ 24.5-27 mm., ♀ 26-28 mm.; hind wing, ♂ 18-19 mm., ♀ 19-21 mm.

36 ♂	19 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
7 ♂	4 ♀	" " Nov., 1894, " " "
	2 ♀	No date or locality.

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43 ♂    25 ♀

This species has hitherto only been recorded from Venezuela.

### 9. *Erythrargrion salvum* Hagen.

*Agrion salvum* HAGEN, Syn. Neur. N. Am., 1861, p. 85; CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 483, Pl. XV, fig. 9.

7 ♂	3 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
1 ♂		" " Nov., 1894, " " "

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8 ♂    3 ♀

On pp. 484, 485, l. c., I called attention to the individual variations in this species being so numerous as to bring into question the generic differences between *Erythrargrion* and *Pyrrhosoma*. I may here say that the armature of the gizzard of *salvum* differs from that of *P. minium* and, to a less extent, from that of *P. tenellum* as figured by Ris, and is described and figured in Part III of this paper.

10. *Ischnura Ramburii* Selys var. *credula* Hagen.

*Agriion credulum* HAGEN, Syn. Neur. N. Am., 1861, p. 80.

*Ischnura Ramburii* var. *credula* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 489, Pl. XV, figs. 5 and 6.

3 ♂ 1 ♀ Acaponeta, Tepic, 300 feet, Nov., 1894, Eisen and Vaslit.

## Subfamily GOMPHINÆ.

11. *Gomphoides pacifica* Selys (?).

*Gomphoides pacifica* SELYS., Bull. Acad. Belg., 2d Ser., Tome XXXVI, 1873, p. 504.

This male differs from de Selys' description only in having the discoidal triangle of the left front wing two-celled, the labrum not traversed as well as bordered in front by black, the antehumeral stripes are confluent with the "demi-collier mesothoracique;" at the apex of the superior appendages not only is the superior but also the inferior angle prolonged into an acute spine, a structural peculiarity apparently not mentioned for any species of *Gomphoides*.

1 ♂ Tepic, Oct., 1894, Eisen and Vaslit.

One female from Tepic, Oct., 1894, may belong here, but is much larger.

12. *Gomphoides suasa* Selys.

*Gomphoides suasa* SELYS., Bull. Acad. Belg., 2d Ser., Tome VII, 1859, p. 545; HAGEN, Proc. Bost. Soc. Nat. Hist., Vol. XVIII, 1875, p. 49; KIRBY, Cat. Odon., 1890, p. 73.

The discoidal triangle of the right hind wing is two-celled.

1 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

13. *Cyclophylla elongata* Selys.

*Cyclophylla elongata* SELYS., Monog. Gomph., 1857, p. 224, Pl. XII, fig. 5.

All the wings with a single basal subcostal cross-vein and one hypertrigonal; seventeen antecubitals on the front wings, first and sixth thicker, eleven to twelve postcubitals on all wings, anal triangle of hind wings four-celled.

2 ♂ Tepic, Oct., 1894, Eisen and Vaslit.

1 ♂     "     Nov., 1894,     "     "     "

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3 ♂

#### 14. *Herpetogomphus viperinus* Selys.

PLATE XXV, FIGS. 1 AND 5.

*Erpetogomphus viperinus* SELYS, Comptes Rendus Soc. Ent. Belg., Tome XI, 1868, p. lxxviii; Bull. Acad. Belg., 2d Ser., Tome XXVIII, 1869, p. 176.

Differ from de Selys' description in having the costa yellow from base to pterostigma, which latter is blackish, although paler at the extremities. The black bands of the thorax in the male are: a submedian on either side of the yellow mid-dorsal carina, not reaching the anterior mesothoracic margin; an antehumeral, of about equal width with the submedian, at its upper end suddenly narrowed to a line by which it reaches the antealar sinus; and a narrower humeral stripe, wider near its upper end. In the female, however, the humeral stripe is absent and the other two are paler in color.

*Male.* Superior appendages with the apices curved downwards as is characteristic for this species, and a small rounded, inferior, sub-basal tubercle. Anterior hamule apparently similar to that figured for *H. crotalinus*<sup>1</sup> except that the posterior branch is longer and more nearly equal in length to the anterior branch. Anal triangle of the hind wings four-celled.

*Female.* Vulvar lamina cleft in more than its apical half, the interval thus formed between the right and left lobes being almost a right angle with straight sides. The appendages a little longer than 10, probably green in life, the tubercle between them of the same color and as long as 10. Base of the wings as far as the triangle with an ill defined pale brownish yellow cloud. The yellow spot on 7 larger than on the other abdominal segments.

*Male and Female.* No basal subcostal cross-veins. Front wings with twelve to fourteen antenodals, first and fifth thicker, nine to eleven postnodals. Hind wings with ten antenodals, first and fifth thicker, nine to ten postnodals.

*Dimensions:* Abdomen, ♂ 33 mm., ♀ 34 mm.; hind wing, ♂ 26.5 mm., ♀ 28 mm.

3 ♂ 3 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

NOTE.—The dimension given for the hind wing of *viperinus* female by M. de Selys in 1869 (l. c.), 37 mm., may be an error, since his original description of 1868, of which that of 1869 is in most respects a copy, gives this as 33, and since the hind wings in *Herpetogomphus* are usually shorter than the abdomen.

<sup>1</sup> Monog. Gomph., Pl. IV, fig. 5/.

15. *Herpetogomphus elaps* Selys.

PLATE XXV, FIG. 2.

*Erpetogomphus elaps* SELYS, Monog. Gomph., 1857, p. 70, Pl. IV, fig. 4.  
*Herpetogomphus elaps* HAGEN, Proc. Bost. Soc. Nat. Hist., Vol. XVIII,  
 1875, p. 42; KIRBY, Cat. Odon., 1890, p. 60.

Although the hind margin of the occiput of this species has been described as "straight," most of these specimens show a tendency towards emargination in the middle, as is actually shown in Monog. Gomph., Pl. IV, fig. 4a.

The female of *elaps* differs from that of *viperinus* chiefly in the absence of the submedian thoracic, and the indistinctness of the antehumeral bands, and by the vulvar lamina being bilobed, the interval between the right and left lobes being deep and semicircular and therefore bounded by curved sides.

The neurational details given for *viperinus* on the preceding page are equally true for *elaps*; the anal triangle of the male is similarly formed and divided.

*Dimensions:* Abdomen, ♂ 33-35 mm., ♀ 31 mm.; hind wing, ♂ 25-26 mm., ♀ 28.5 mm.

6 ♂	1 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
7 ♂	1 ♀	" Nov., 1894, " " "

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13 ♂      2 ♀

The characters which Baron de Selys used in the latest synopsis of the species of *Herpetogomphus*,<sup>1</sup> viz.:—

A. Pterostigma black. Black patterns of the body well marked. *H. compositus*, *designatus*, *viperinus*.

B. Pterostigma brown or yellowish. Brown patterns of the body obliterated in part. *H. menetriesii*, *elaps*, *boa*, *cophias*, *crotalinus*.

seem to be of little value, judged by the two species of *Herpetogomphus* here represented. In some individuals of *elaps* the pterostigma is quite as black as in *viperinus*, and the dark bands of the female *viperinus* are but little better defined than in some individuals of *elaps*. Unfortunately, after pointing out the defects of this grouping, I have nothing to offer as a substitute, owing to insufficient materials.

<sup>1</sup> Comptes Rendus Soc. Ent. Belg., 1879, p. lxiii.

Subfamily *ÆSCHNINÆ*.16. *Æschna macromia* Brauer.

*Æschna macromia* BRAUER, Verhdl. zool.-bot. Ges., Wien, Bd. XV, 1865, p. 906; Reise d. Novara, Neur., 1866, p. 68, Pl. I, fig. 18.

1 ♂ Acaponeta, Tepic, 300 ft., Nov., 1894, Eisen and Vaslit.

Hitherto recorded from Brazil only.

17. *Æschna* (Group of *diffinis* RAMBUR).

1 ♀ ; no locality or date.

18. *Æschna luteipennis* Burmeister.

*Æschna luteipennis* BURM., Handb. Ent. II, 1839, p. 837; CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 503, Pl. XV, figs. 27 and 28.

1 ♂ Tepic, Oct., 1894, Eisen and Vaslit.

19. *Gynacantha*, sp.

1 ♀ Tepic, Nov., 1894, Eisen and Vaslit.

20. *Anax amazili* Burmeister.

*Æschna amazili* BURM., Handb. Ent. II, 1839, p. 841.

*Anax amazili* HAGEN, Psyche, Vol. V, 1890, p. 307.

1 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

Guatemala is the most northern locality on the North American continent from which this species has been previously recorded.

Subfamily *LIBELLULINÆ*.21. *Tramea onusta* Hagen.

*Tramea onusta* HAGEN, Syn. Neur. N. Am., 1861, p. 144; CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 513, Pl. XVII, figs. 85-87.

1 ♀ Tepic, Nov., 1894, Eisen and Vaslit.

22. *Miathyria marcella* Selys.

*Libellula marcella* SELYS, in Sagra, Hist. Cuba, Ins., 1857, p. 452.

*Tramea marcella* HAGEN, Stett. Ent. Zeit., Bd. XXVIII, 1867, p. 227.

*Miathyria marcella* KIRBY, Cat. Odon., 1890, p. 4.

*Tramea simplex* HAGEN, Syn. Neur. N. Am., 1861, p. 146, (teste Hagen).

As compared with Hagen's description of 1867, the following differences exist:—

In younger individuals of both sexes only the free margin of the labrum is black, the remainder of the labrum ochre brown which becomes darker with age. The dark brown basal band on the hind wings of the female does not extend farther outwards than in the male, i. e., a very short distance beyond the submedian cross-vein,<sup>1</sup> nor is the amount of surrounding yellow greater than in the male. The venation is yellowish without a red tinge.

Compared with Kirby's statement of the generic characters of *Miathyria*<sup>2</sup> it is to be noted that some individuals show the inner (basal) side of the triangle of the hind wings to be a little nearer the base of the wing than is the arculus, instead of being in the prolongation of this latter.

*Dimensions:* Abdomen, ♂ 25-27 mm., ♀ 27 mm.; hind wing, ♂ 32-34 mm., ♀ 33 mm.

1 ♂	1 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
2 ♂	2 ♀	" Nov., 1894, " " "
2 ♂		No locality or date.
<hr/>		
5 ♂	3 ♀	

The described species of *Miathyria* are very similar to each other; the chief differences appear to be as follows:—

1. *Miathyria marcella* Selys.

Basal spot on the hind wings extending but little beyond the submedian cross-vein (or rarely to the triangle in the female). Reticulation of a greater number of cells than in *simplex*. Black spots on abdominal segments 5-10. Size moderate (abdomen 23-27 mm., hind wing 30-34 mm.) Vulvar lamina of female bilobed, lobes slender and a little longer than the interval separating them.

<sup>1</sup> I adopt henceforth the following changes in the nomenclature of the wings of Odonata proposed by Baron de Selys (Ann. Soc. Ent. Belg., Tome XI, p. 85, March, 1896). *Costal space* between the costal and subcostal veins, *subcostal space* between the subcostal and median veins, *median space* (formerly basilar space) between the median and submedian veins; *submedian space* between the submedian and postcostal veins; in it is the *normal submedian cross-vein*, which has been called postcostal cross-vein in the Agrionidæ and normal median cross-vein in the Libellulidæ and Aeshnidæ; *postcostal space* between the postcostal vein and the hind margin of the wings; it is wanting in those Agrionidæ where the hind margin only commences beyond a petiolate base.

<sup>2</sup> Proc. Zool. Soc. Lond., Vol. XII, 1889, p. 269.

**2. *Miathyria simplex* Rambur.**

Basal spot on hind wings extending into the triangle. Black spots on 5-10. Size moderate (abdomen 22 mm., hind wing 27 mm.) Vulvar lamina emarginated, not bilobed.

**3. *Miathyria pusilla* Kirby.**

(From Kirby's description and figure.) Basal spot on hind wings extending to the triangle. Black spots on 3-10. Size small (abdomen 20 mm., hind wing 25 mm.)

Mr. Kirby states<sup>1</sup> that he is now inclined to think *pusilla* "is synonymous with *M. simplex* Ramb." His *Miathyria flavescens*, described on the same page, seems from his description and figure to be rather a *Macrothemis*.<sup>2</sup> *Tetragoneuria balteata* Hagen, which he doubtfully refers to *Miathyria* in his Catalogue, page 4, is not of this genus, as it has the front wings with the last antenodal continuous, the subtriangular space (internal triangle) of different shape and two-celled, sectors of the arculus not stalked; on the hind wings the inner (basal) side of the triangle is a little nearer the base than the arculus. I do not know its proper generic position.

**23. *Pseudoleon superbus* Hagen.**

*Celithemis superba* HAGEN, Syn. Neur. N. Am., 1861, p. 148.

*Pseudoleon superbus* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 518, Pl. XVI, figs. 62-66.

1 ♂ 1 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

**24. *Orthemis ferruginea* Fabricius.**

*Libellula ferruginea* FABR., Sys. Ent., 1775, p. 423.

*Orthemis ferruginea* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 520, Pl. XVI, figs. 67-69.

6 ♂ 5 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

10 ♂ 7 ♀ " Nov., 1894, " " "

2 ♂ Mazatlan, Eisen and Vaslit.

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18 ♂ 12 ♀

<sup>1</sup> Ann. Mag. Nat. Hist., 6th Ser., Vol. XIX, 1897, p. 600.

<sup>2</sup> See on this Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, p. 328.

### 25. *Dythemis velox* Hagen, var. *sterilis* Hagen.

*Dythemis velox* HAG. var. *sterilis* HAG., CALVERT, PROC. BOST. SOC. NAT. HIST., Vol. XXVIII, 1898, p. 310.

*Dythemis sterilis* HAGEN, Syn. Neur. N. Am., 1861, p. 317; CALVERT, PROC. CAL. ACAD. SCI., 2d Ser., Vol. IV, 1893-94, p. 522, Pl. XVI, figs. 52-55.

*Dythemis Broadwayi* KIRBY, Ann. Mag. Nat. Hist., 6th Ser., Vol. XIV, 1894, p. 227.

2 ♂	8 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
1 ♂	2 ♀	" Nov., 1894, " " "
6 ♂	5 ♀	No date or locality.

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9 ♂ 15 ♀

I have examined the type of *D. Broadwayi* Kirby from Trinidad and find it to be identical.

### 26. *Dythemis velox* Hagen, var. (?) *nigrescens* var. nov.

*Male* very similar to *sterilis* male, but the vertex and the frons superiorly dark metallic violet or blue, a crescentic black spot on the nasus, labrum black, but green along the base in the younger individuals, lateral labial lobes barely edged with black on their inner edge or this black as wide as one-fifth of the width of the lobe; pale green or yellow stripes on 4-6 half as long, on 7 half to two-thirds as long, on 8 one-third as long as the respective segments, a pale spot on the middle of each side, 10 unspotted; wings uncolored at the base, brown at apex for the width of but one cell.

*Female* very similar to *sterilis*, vertex luteous, frons luteous or pale green with a metallic violet point in the superior groove at its base, no spot on the nasus, labrum pale green or luteous, edged with black at the middle of the free margin, lateral labial lobes barely edged with black along their inner margins, pale green or yellow markings on 4-7 two-thirds as long (or more) as the segments, on each side of 8 a double pale spot at the base and one at the apex, lateral margin of 9 with a yellow stripe, 10 unspotted or with a pale point each side, wings yellowish at base, brown in the subcostal spaces half-way to the first antenodal on all the wings, and in the submedian space of the hind wings to the cross-vein, brown at the apex, varying from a width of but one cell to a band reaching to the outer end of the pterostigma.

*Dimensions*: Abdomen, ♂ 28-29.5 mm., ♀ 28-31 mm.; hind wing, ♂ 33-34 mm., ♀ 33-35 mm.

20 ♂	21 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
1 ♂	8 ♀	" Nov., 1894, " " "
1 ♂	3 ♀	No locality or date.

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22 ♂ 32 ♀



Here also belong the 17 males from San José del Cabo, October, 1893, briefly described on p. 525, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV. As some of these Tepic males are, however, younger individuals, and as the female sex is also represented, I have briefly described them to supply certain deficiencies in the passage quoted.

There are a number of allied forms or varieties occurring in Central and South America, differing apparently only in slight color variations of the parts above mentioned, but not structurally or in neuration.

### 27. *Brechmorhoga mendax* Hagen.

*Dythemis mendax* HAGEN, Syn. Neur. N. Am., 1861, p. 1864; CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 529, Pl. XVI, figs. 56 and 57. *Brechmorhoga mendax* CALVERT, Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, p. 313, Pl. I, fig. 5; Pl. II, figs. 23, 30.

The male has the frons and vertex metallic blue, the discoidal triangle of the right front wing free.

Hagen (l. c.) says "segments 1-7 with a double spot each side upon the dorsum greenish white;" in one of his two male types these spots are very small on 6.

1 ♂ 1 ♀ Tepic, Nov., 1894, Eisen and Vasilit.

The genus *Brechmorhoga* was established by Mr. Kirby for *B. grenadensis*, sp. nov., from Grenada, West Indies.<sup>1</sup> Mr. Kirby, in reply to my query, has kindly written:—

"I have examined the specimens of *Brechmorhoga*, and find that the tarsal nails are toothed close to the tip, but the lower tooth is decidedly shorter than the other. As regards the femora, I find that the teeth in the middle femora are short and straight, more like serrations, and do not apparently differ from those in *Dythemis*, but on the hind femora they are larger than in *Dythemis*, with a distinct inclination towards the knee" [surely trochanter instead of knee].

*Brechmorhoga* is, as stated by Mr. Kirby, closely related to *Macrothemis*, agreeing therewith in the femoral characters above mentioned<sup>2</sup> (which are true for the male, not for the female), but differing in the tarsal nail being toothed, not

<sup>1</sup> Ann. Mag. Nat. Hist., 6th Ser., Vol. XIV, 1894, p. 265.

<sup>2</sup> "Postero-inferior," lines five and six from the bottom, p. 531, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, should be "antero-inferior."

bifid, and in the greater width of the post-triangular field of the front wings—the number of rows increasing to more than two from, usually, the level of the point of separation of the median and principal sectors. To *Brechmorhoga* belong *mendax* Hag., *præcox* Hag., *pertinax* Hag., *nubecula* Ramb., and probably *Sallæi* Selys; I have studied the types of the first three and hope soon to publish a synopsis of the differences of all these closely related species.<sup>1</sup>

## 28. *Brechmorhoga postlobata* Calvert.

PLATE XXV, FIG. 12.

*Brechmorhoga postlobata* CALVERT, Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, p. 314 (very brief diagnosis).

*Male.* Colors somewhat faded. Face pale brown, vertex and superior part of frons dark metallic blue-green. Lips yellowish, labrum with a median spot and the middle of the free margin brown, median lobe and inner third of lateral lobes of labium brown. Occiput and rear of head brown, two or three pale spots behind the eyes.

Prothorax light brown. Thoracic dorsum dark brown, a green antehumeral stripe widened abruptly on its inner side at its upper end; sides pale green with two ill defined, oblique, brown stripes, one on the site of the lower half of the first lateral suture, the other on the second lateral suture. Legs blackish, bases of all femora and the first pair inferiorly pale brownish.

Abdomen compressed at base, slender at base of 4, thence widening to the base of 8, and thence narrowing to apex; black, dorsum of 2-5 with a narrow, pale brown stripe each side, reduced to a pair of basal dots on 6 and on 8, greatly widened and almost as long as the segment on 7; ventral surface of 1-9 with a pale brown streak each side.

Superior appendages slightly longer than 9, directed downwards and inwards in the apical half, somewhat thicker before the apex, with an inferior row of about nine denticles in the third and fourth fifths of their length, apex moderately acute. Inferior appendage very little (about one-tenth) shorter than the superior appendages, triangular, apex truncated, terminating in two denticles directed upwards, which reach beyond the denticles of the superiors.

Genitalia of 2: anterior lamina entire, projecting equally with the genital lobe. Hamule projecting still farther, not bifid, sickle-shaped, apex acute. Genital lobe oblong, peculiar in having a posterior basal tubercle (wanting in all other species of this genus), apex of lobe itself and of this tubercle hairy.

Wings with a faint yellowish tinge, extreme base darker yellow for the

<sup>1</sup> This synopsis was written subsequent to the preparation of the present paper, but published before it in Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, pp. 301-332, 2 pls., under the title of "The Odonate genus *Macrothemis* and its allies."

distance of about one cell in the postcostal space, reticulation black, pterostigma dark brown, surmounting one cell and parts of two others, outer end more oblique than the inner, membranule dark brown. Front wings with eleven antenodals, six to seven postnodals, triangle free, two post-triangular rows increasing to three at the level of the origin of the subnodal sector, internal triangle three-celled. Hind wings with eight antenodals, eight postnodals, triangle free, its inner side slightly nearer the base than is the arculus, two post-triangular rows increasing.

*Dimensions:* Total length 50 mm.; abdomen 37 mm.; hind wing 32.5 mm.; pterostigma 2.5 mm.

2 ♂ Tepic, Nov., 1894, Eisen and Vaslit.

A male in the Museum of Comparative Zoology, Cambridge, Mass., from Mazatlan, Mexico, October, 1873, by Crotch, is evidently of the same species, but presents these variations: a mere trace of metallic blue on frons and vertex, entire free margin of labrum bordered with black, only a median black spot on the median labial lobe, and the inner edges of lateral labial lobes but very narrowly edged with black, the two brown stripes on the sides of the thorax fused together, pale spot on 7 a little more than half as long as the segment, inferior appendage about one-fourth shorter than the superiors, tip of hamule a little more slender, internal triangle of right front wing with one cross-vein, right hind wing with nine antenodals.

*Dimensions:* Total length 47 mm.; abdomen 36 mm.; hind wing 32 mm.; pterostigma 2 mm.

The specific name *postlobata* refers to the posterior basal tubercle on the genital lobe which is not possessed by any other species of *Brechmorhoga*.

## 29. *Macrothemis pseudimitans* Calvert.

*Macrothemis pseudimitans* CALVERT, Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, p. 329, Pl. II, fig. 35.

*Macrothemis imitans* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 531, Pl. XVI, figs. 33, 35-39 (not of Karsch).

The green colors of this female have been reddened by the alcohol. Triangle of the left front wing with one cross-vein. Internal triangle of front wings two-celled (right), three-celled (left).

1. ♀ Tepic, Nov., 1894, Eisen and Vaslit.

On examining the types of *M. imitans* Karsch in the Königliche Museum für Naturkunde, Berlin, I found that they differed from the individuals I described as *imitans* in the following respects:—

1. The superior appendages of the male have on their under surface a triangular tooth which is denticulated on its basal side (as in *M. inequiunguis* Calvert). Dr. Karsch's description<sup>1</sup> of *imitans* says of these appendages, "am Unterrande gezähnt," an expression which, it seems, may equally well mean "provided with a tooth," as in the case of *imitans* types, or "provided with denticles," as in the individuals I referred to *imitans*. As, however, the type of *Macrothemis (celano)* Selys and most of the species of this genus have an inferior row of denticles, not a large tooth, one would be justified in accepting the interpretation "provided with denticles" in the absence of express statement to the contrary.
2. The hamule of the male is more slender in *imitans* types.
3. The antehumeral spots in *imitans* type are shorter (1 mm. long), reaching from in front of the antealar sinus only one-third of the distance to the anterior mesothoracic margin; longer (2.5 mm.) in the Baja Californian species, reaching almost to the anterior mesothoracic margin.
4. Sides of the thorax with three green spots in *imitans* types, due to the absence of the fourth of the other species, or upper of the two on the metepimeron.
5. The difference in the coloring of the wings mentioned, l. c., p. 533, which is perhaps of slight importance, as the individual variation in this respect is quite considerable in *Macrothemis*.

It therefore became necessary to rename my *imitans* and I proposed *pseudimitans* instead.

### 30. *Macrothemis inequiunguis* Calvert.

*Macrothemis inequiunguis* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 533, Pl. XVI, figs. 34, 40-45; Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, pp. 317, 319, Pl. I, fig. 2.

The males differ from the types in having both lips black, the brown stripes on the lateral thoracic sutures much broader, front wings with thirteen antenodals, nine postnodals, and by larger size—abdomen 27 mm., hind wing 31 mm.

The females are like the types, but have thirteen antenodals on the front wings.

2 ♂ 2 ♀ Tepic, Nov., 1894, Eisen and Vaslit.

<sup>1</sup> Berl. Ent. Zeit. Bd. XXXIII, p. 367.

31. *Macrothemis inacuta* Calvert.

PLATE XXV, FIGS. 7, 10.

*Macrothemis inacuta* CALVERT, Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, pp. 318, 328 (very brief diagnosis.)

*Male.* Vertex brown, tip metallic blue. Frons deeply grooved above, olive or pale bluish in front, metallic blue just before the vertex and extending down in a narrow limb on either side, anterior surface much pitted. Clypeus luteous or olivaceous. Labrum luteous or with the free margin narrowly black. Labium luteous or brown, darker on the median lobe and on the adjoining parts of the lateral lobes. Occiput luteous, extending forwards between the eyes so that the distance they are in contact is less than the length of the occiput. Rear of the eyes brown with two pale green spots.

Prothorax luteous. Thorax brown, a pale green antehumeral stripe each side which is much and abruptly widened on the inner side at its upper end; humeral and lateral sutures with ill defined blackish stripes; a narrow, oblique, pale green or yellow mesepimeral stripe interrupted in the middle of its course; an oblong yellow or pale green spot on the metepimeron just above the latero-ventral metathoracic carina, and a small, ill defined pale cloud below the base of the hind wings.

Legs luteous or brown, darker or even blackish inferiorly, spines of the posterior (inner) row of the third tibiae shorter, stouter, and slightly more numerous (16) than those of the anterior row (13).

Abdomen of almost uniform width, very slightly narrower at 3; luteous, articulations and carinae with black lines, 3-9 with an ill defined brownish stripe from base to middle on 3, nearly to apex on 4-9, on either side of the dorsum, ventral surface darker.

Superior appendages almost as long as 9+10, slightly arched, apex rounded, not pointed, thicker before the apex, with an inferior conical tooth at three-fourths the length from the base, this tooth being itself denticulated at tip. Inferior appendage about one-seventh shorter, about twice as long as its width at base, apex narrow, ending in the usual two upturned denticles.

Genitalia of 2: anterior lamina slightly less prominent than the hamule, profile of the former conical, with a rounded apex. Hamule with its apical half very slender and curved backwards and somewhat upwards to form a hook. Genital lobe projecting about half as much, tapering, tip rounded.

Wings with or without a faint yellowish hue, with a brown tinge at the extreme base of the subcostal and median veins. Pterostigma blackish brown (yellow in the Guatemala male), outer and inner ends oblique. Membranule white. Front wings with thirteen to fourteen antenodals, seven to eight postnodals, triangle free, internal triangle two-celled, two post-triangular rows to the level of the nodus (three cells, then two rows in one wing 1 male) increasing to four to six marginal cells. Hind wings with nine to eleven antenodals, eight to ten postnodals, two post-triangular cells, the upper usually reaching across the entire width of the field, then two rows to the level of the origin of the subnodal sector increasing to nine to fourteen marginal cells.

Female differs from the male as follows: No metallic blue on vertex and very little on the frons, which is cream color anteriorly. No black border to the labrum. Spines of the posterior (inner) row of the third tibiae very little shorter, no stouter, but slightly more numerous (18) than those of the anterior row. Abdomen not narrower at 3. Appendages twice as long as 10, shorter than 9, straight, dark brown. The faint yellow of the wings is better marked between the nodus and pterostigma in one female; hind wings with the dark brown streak at the base of the subcostal and median veins half-way or more to the first antenodal, and a deep yellow cloud from submedian vein to a short distance beyond the apex of the membranule (1 female), or to the hind margin of the wing (1 female), and whose distal boundary is the submedian cross-vein and distal sub-basal sector (of Kirby). Pterostigma paler. No post-triangular cell reaches across the entire width of the field in the hind wings, where the larger female has three cells, then two rows.

*Dimensions:* Total length, ♂ 43-45 mm., ♀ 42.5-45 mm.; abdomen, ♂ 30.5-35 mm., ♀ 31-32.5 mm.; front wing, ♂ 33-35 mm., ♀ 35.5-37 mm.; hind wing, ♂ 31.5-33 mm., ♀ 34-35.5 mm.; pterostigma 2.5-2.75 mm.; superior appendages, ♂ 2 mm.; appendages, ♀ 1 mm.; hind tibia 5.5 mm.

1 ♂ Tepic, Oct., 1894, Eisen and Vaslit.

Besides the male from Tepic, quoted above, I have, with the permission of Mr. Samuel Henshaw, used, as types of the above description, the following specimens in the Museum of Comparative Zoology, Cambridge, Mass.:—

One male, Acapulco, Mex., by A. Agassiz; one male (last six abdominal segments lost) and two females, Isthmus of Tehuantepec, by F. Sumichrast; one male (badly damaged, head lost) Guatemala, Coll. Van Patten.

The specific name *inacuta* was chosen instead of *obtusa* to avoid the use of a name which has already been twice employed in the Odonata. *Inacuta* refers to the blunt apex of the superior appendages of the male, a character not possessed by any other *Macrothemis*.

### 32. *Trithemis basifusca* Calvert.

*Trithemis basifusca* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 536, Pl. XVI, figs. 58-61.

*Male* differs from the types from Baja California in that the basal spot of the hind wings is paler brown and usually does not extend outwards quite as far as the first antenodal, in extreme cases barely reaching the submedian cross-vein. Like the types, the labrum is blackish with a narrow yellowish

border, while the adjacent clypeus and the labium are in many cases much paler and even green or yellowish. In the teneral males abdominal segments 1-7 are pale green, mid-dorsal carina of 3-7, a lateral stripe on 1-3, and lateral margins of 4-7 (wider in posterior half) brown. Abdomen beneath dark brownish with indistinct paler spots at the bases of the segments.

*Female* pattern of coloring of abdomen as here described for teneral males, but 8-10 are similar to 6 and 7.

22 ♂ 13 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

7 ♂ 3 ♀ " Nov., 1894, " " "

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29 ♂ 16 ♀

After comparing a type male of *basifusca* with specimens of *abjecta* Ramb. and *fusca* Ramb., identified by Baron de Selys, in the Museum of Comparative Zoology, Cambridge, I incline to my first opinion<sup>1</sup> that *basifusca* is synonymous with *abjecta*. Mr. McLachlan wrote me, "On making a casual comparison with a specimen from Brazil labeled '*fusca* Rbr.' by Selys, it is difficult to find any good character save that the basal spot in the latter is rather more extended." I leave *basifusca* under these suspicions until a review of the American species of *Trithemis* shall be made.

### 33. *Trithemis Montezuma*, sp. nov.

*Female*. Vertex, concave at tip, and frons dark plum color with a slight metallic reflection. Sides of frons and clypeus pale greenish. Lips luteous. Eyes in contact for a distance nearly equal to the length of the occiput, which is black above, yellow behind. Rear of head yellow with some obscure darker marks.

Thorax and abdomen dark brown, pruinose, through which some yellow appears near the bases of the legs. These brown, tibiae paler, tarsi blackish. Abdominal appendages yellowish, longer than 10, not quite as long as 9. Vulvar lamina one-sixth as long as 9, erect, margin rounded, entire.

Wings somewhat milky. Reticulation, membranule and pterostigma dark brown, the latter surmounting one cell and parts of two others, arculus a little nearer the base than the second antenodal, nodal sector very slightly waved beyond its middle, at least some double cells between the subnodal sector and the supplementary sector next below. Front wings brownish at base to about the level of the submedian cross-vein, but its limit nowhere sharply marked, apex brown for a width of two cells, eleven antenodals, eight

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<sup>1</sup> I. c., p. 537.

postnodals, triangle with one cross-vein, internal triangle of three cells, three post-triangular rows to the level of the nodus increasing to seven marginal cells, upper sector of the triangle curved strongly forwards without affecting the number of post-triangular rows but merely rendering the cells smaller. Hind wings brown in the subcostal space to the second antenodal, the brown overflowing into the costal and median spaces, which are somewhat clearer, a large brown spot from the submedian vein nearly to the hind margin of the wing and outwards to the level of the triangle, the centers of the cells within this spot clearer, apex brown for a width of three cells, nine antenodals (the last one on the left side of the broken female is not continued to the median vein), nine to ten postnodals, triangle free, two post-triangular rows to the level of the separation of median and principal sectors, increasing to ten to eleven marginal cells.

*Dimensions:* Total length 42 (?) mm., abdomen 30 (?) mm. (I have unfortunately neglected to make these measurements from the entire female), hind wing 30 mm., pterostigma 4.5 mm.

1 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

1 ♀ No date or locality, " " " (last six segments lost).

2 ♀

I have not been able to find any description of this species nor any named specimen in any museum.

### 34. *Trithemis funerea* Hagen.

*Libellula funerea* HAGEN, Syn. Neur. N. Am., 1861, p. 158.

*Belonia funerea* KIRBY, Cat. Odon., 1890, p. 29.

The shape of the appendages and of the genitalia of the second abdominal segment of the male and of the vulvar lamina of the female is the same as in *T. umbrata* L. The oldest individuals of both sexes have the body, including the legs, black, both front and hind wings blackish brown from the base to a little more than half-way from nodus to pterostigma. In younger males, at least, the front wings may be clear from the base almost to the nodus, smoky brown from the nodus half-way to the pterostigma, the hind wings with the basal fourth clear, succeeded by smoky brown to the middle point between nodus and pterostigma. In teneral males and females the colors of the body are like those of teneral *umbrata*, the wings are usually yellowish from the base to a little more than half-way between nodus and pterostigma. In individuals of all ages, therefore, *umbrata* is to be distinguished by the transverse band of the wings having its outer margin at the inner end of the pterostigma, while in *funerea* the outer margin of the yellow or dark coloring lies only a little beyond the half-way point between nodus and pterostigma.



9 ♂	8 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
16 ♂	15 ♀	" Nov., 1894, " " "
1 ♂		Mazatlan, Eisen and Vaslit.
1 ♂	1 ♀	No date or locality. Eisen and Vaslit.

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27 ♂ 24 ♀

I may remark here that my experience does not agree with Hagen's statement<sup>1</sup> that "the female [*umbrata*] with the band of the wings as in the male is *very rare*," (the italics are mine), although such females are of course much less common than the females without banded wings. The difficulty of distinguishing between *umbrata* females without the bands and teneral females of *funerea* which have not yet developed the yellow or dark coloring as described above is considerable, especially as the present collection contains some females in which the only apparent coloring to the wings is yellow along the anterior margins, and the apex from the outer end of the pterostigma brown. These I also refer to *funerea* because they possess a neurational peculiarity to be found in undoubted *funerea*, viz., that on the front wings there are two rows of cells between the short sector and the supplementary sector next below, while in *umbrata* (with the exception of one male from Jamaica) there is but a single row of cells in this place. Whether this is a fairly constant difference remains to be established or disproven by the examination of a greater number of individuals than I have been able to study.

### 35. *Micrathyria Hageni* Kirby.

*Micrathyria Hageni* KIRBY, Cat. Odon., 1890, p. 41; CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 540, Pl. XVII, figs. 95-97.

1 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

1 ♀ Acaponeta, Tepic, 300 ft., Nov., 1894, Eisen and Vaslit.

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<sup>1</sup> Proc. Bost. Soc. Nat. Hist., Vol. XVIII, 1875-76, p. 72.

36. *Micrathyria aequalis* Hagen.*Dythemis aequalis* HAGEN, Syn. Neur. N. Am., 1861, p. 167.*Micrathyria aequalis* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 543, Pl. XVII, figs. 107-109.

2 ♂	2 ♀	Tepic, Oct., 1894, Eisen and Vaslit.
	4 ♀	No locality or date, " " "
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2 ♂	6 ♀	

37. *Micrathyria*, sp.

1 ♂ Tepic, Nov., 1894, Eisen and Vaslit.

Teneral and much damaged; I have not been able to identify it, but it apparently belongs to the group of *berenice* Drury. To the same group belong *nova* Hagen and *debilis* Hagen, the types of which I have studied.

38. *Anatya normalis*, sp. nov.

PLATE XXV, FIGS. 9, 13.

*Male* (teneral). Frons and clypeus pale green, the former with a superior, quadrangular, brown spot having a slight metallic bluish reflection, vertex colored like this spot, its tip slightly concave, not convex, as stated by Kirby.<sup>1</sup> Lips yellow. Rear of head brown with some yellow spots behind the eyes. Eyes in contact for a distance barely half the length of the occiput, which is brown above, yellow behind.

Thorax bright yellow. Prothorax with a pale reddish brown spot each side on the middle lobe; hind lobe distinctly narrower than the middle lobe, subquadrangular with the angles slightly rounded off, with a distinct mid-dorsal groove and a shallow, median, posterior emargination. On either side of the thoracic dorsum some pale reddish brown marks forming a hollow oblong which does not reach the antealar sinus, but whose outer side is prolonged thereto; a small spot to the outer side of this oblong and lines on the humeral and second lateral sutures of the same color.

Legs yellow, tibiae, tarsi and apices of the femora dark brown; third tibiae with seven to nine spines on the anterior (outer) row, sixteen to eighteen on the posterior (inner) row.

Abdomen slightly narrower in segments 4 and 5, but neither base nor apex are much widened; 1 and 2 bright yellow, the sutures and carinae pale brown, following segments brown, 3-5 with a yellow stripe each side from the base

<sup>1</sup> For *Anatya*; Trans. Zool. Soc. Lond., Vol. XII, 1889, p. 293.

(where it is widest) almost to the apex on 3, three-fourths as long as the segment on 4, half as long on 5, 6 with a yellow spot each side occupying the middle two-fourths of the segment, 7 with a small spot near the middle of each side; inferiorly the abdomen is pale yellowish brown.

Superior appendages as long as 9+10, yellow, brown at base and at tip, curved downwards in the basal half, nearly straight in the apical half, with a well marked, median, inferior tooth, whose basal side bears five to six black denticles, apex gradually tapering, very acute. — Inferior appendage two-thirds as long, yellow, brown at the extreme tip, which ends in the usual two up-turned denticles and extends beyond the inferior tooth of the superiors.

Genitalia of 2 inconspicuous; anterior lamina less prominent than hamule or genital lobe, its margin slightly bilobed; hamule bifid, inner branch shorter, more slender, hook-like, apex acute, outer branch twice longer and twice wider, apex blunt; genital lobe equally prominent with the outer hamular branch, rounded.

Wings clear, reticulation blackish, pterostigma and the very small membranule dark brown, the former surmounting one cell and parts of two others. Neuration as described by Kirby,<sup>1</sup> except that there are eleven postnodals on the hind wings.

1 ♂ Tepic, Nov., 1894, Eisen and Vaslit.

The neuration of *Anatya* is almost identical with that of *Micrathyria*; in the former the hind wings are widest at the level of the nodus and become so much narrower towards the base that but one row of cells exists between the proximal subbasal sector and the hind margin; in *Micrathyria* the greatest width of the same wings is near the level of the middle antenodal, whence the narrowing towards the base is so much less that three rows of cells are found between the proximal subbasal sector and the hind margin.

Although this male is probably not fully colored, the difference in its superior appendages from those of *guttata* Erichson (which Mr. Kirby appropriately named *anomala*) justifies the application of a new specific name, *normalis*, as these appendages are quite of the usual style.

### 39. *Sympetrum illotum* Hagen.

*Mesothemis illota* HAGEN, Syn. Neur. N. Am., 1861, p. 172.

*Diplax illota* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 545, Pl. XVII, fig. 114-119.

*Sympetrum illotum* KIRBY, Cat. Odon. 1890, p. 17.

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<sup>1</sup> I. c., 1889, p. 294.

1 ♂ Tepic, Oct., 1894, Eisen and Vaslit.

1 ♂ " Nov., 1894, " " "

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2 ♂

#### 40. *Perithemis domitia* Drury.

*Libellula domitia* DRURY, Ill. Exot. Ent., Vol. II, 1773, Pl. XLV, fig. 4.

*Perithemis domitia* HAGEN, Syn. Neur. N. Am., 1861, p. 185; KIRBY, Trans. Zool. Soc. Lond., Vol. XII, 1889, p. 325; Ann. Mag. Nat. Hist., 6th Ser., Vol. IV, 1889, p. 232; CALVERT, Trans. Am. Ent. Soc., Vol. XX, 1893, p. 264; Vol. XXV, 1898, p. 75.

*Libellula tenera* (♀), *L. tenuicincta* (♂) SAY, Journ. Acad. Nat. Sci., Phila., Vol. VIII, 1839, p. 31.

15 ♂ 16 ♀ Tepic, Oct., 1894, Eisen and Vaslit.

4 ♂ 7 ♀ " Nov., 1894, " " "

2 ♂ 2 ♀ No locality or date, " " "

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21 ♂ 25 ♀

Of the species referred to *Perithemis*, *domitia* Drury, from Jamaica, was the first described. Mr. Kirby<sup>1</sup> regards *domitia* as specifically distinct from various forms of *Perithemis* found on the North American mainland; while other authors, following Hagen, have united Say's *tenera* and *tenuicincta* with *domitia*, and may, perhaps, be disposed to do the same with *intensa* Kirby, and even with still other nominal species. Since Mr. Kirby's work is of later date than Hagen's, it may be well to examine the grounds on which he has regarded them as distinct.

1. *Domitia* he believes to recognize in specimens from Jamaica in the Dublin Museum and from St. Domingo in the British Museum.<sup>2</sup> From these two references it appears that he regards as one important specific character that the subtriangular space [or internal triangle] on the front wings is divided by a perpendicular nervure into two cells, and he

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<sup>1</sup> Cat. Odon., 1890, p. 10.

<sup>2</sup> Ill. cc., 1889, pp. 232, 325.

expressly says (p. 325), "Drury's figure was taken from a Jamaica specimen, and although it is rough<sup>1</sup> and probably represents too many costal nervures, the subtriangular space of the fore wings is distinctly represented as consisting of two cells." An examination of Drury's figure will show that Mr. Kirby's description is true only for the right front wing, as the left front wing has the subtriangular space just as distinctly represented as consisting of three cells. Moreover, although Mr. Kirby's description of *domitia*<sup>2</sup> states that the [discoidal] triangles are free, the same figure of Drury's shows the triangle to be crossed by two veins in the left front wing. Any one possessing similarly colored *Perithemis* from Jamaica, with the subtriangular spaces three-celled and the triangles crossed on the front wings, would be equally justified in regarding them as *domitia* Drury. The bearing of the number of cells in these parts of the wing on the question of specific distinction will be seen farther on.

2. *Tenera* Say and *tenuicincta* Say, in spite of the great difference in the coloring of their wings, are beyond question female and male respectively of the same species, as Hagen indicated in 1861, and as the writer and other collectors can testify from personal experience. Why they should appear as distinct from each other in Mr. Kirby's Catalogue is inexplicable.

3. "*Tenuicincta*"—the male—of the mainland, usually has the subtriangular space on the front wings free (of one cell) and all the triangles free; many individuals have a brown spot of *varying intensity* lying in the outer ends of the triangle, supra-triangular space and the adjoining cells, on all the wings. *Not all* individuals, however, and it is not uncommon to find in one and the same locality, as in the vicinity of Philadelphia, some with and others without these brown spots. Neither the *domitia* of Drury's figure,

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<sup>1</sup> So rough that I believe it to be utterly untrustworthy as regards the venation.

<sup>2</sup> Ann. Mag. Nat. Hist., 1. c.

nor of Mr. Kirby's description, possesses these brown spots, but the facts just stated show that their presence or absence can not constitute a specific character. How does the case stand as regards the number of cells in the subtriangular space? Fourteen males from Cuba, in the Museum of Comparative Zoology at Cambridge and in the Collection of the American Entomological Society in Philadelphia, whose yellow wings are unspotted with brown, vary as follows: four have the subtriangular space free in both front wings, five have it free in one front wing and of two cells in the other, five have it of two cells in both front wings. Therefore, neither the number of cells in the subtriangular space, nor the presence or absence of a brown spot on the wings separates *domitia*, male, from *tenuicincta*, and until some other character is discovered which is distinctive, the latter name must be a synonym of the former. Since *tenera* is the female of *tenuicincta*, it, too, must consequently be a synonym of *domitia*. What the neuronal variations of the females may be I am unable to state, as very few West Indian females exist in the collections above mentioned. The females from the United States, like the males, usually have the subtriangular spaces free, but one female not otherwise distinguishable has them two-celled.

4. This absence of females from the West Indies prevents an expression of opinion on *pocahontas* Kirby and *mooma* Kirby, but it is difficult to see that the wing markings, which are the chief distinctive features, differ more from those of "*tenera*," than do extreme individuals of "*tenera*" from each other.

5. *Intensa* Kirby from Mexico, described from the male only, has no brown spots on the (almost) uniformly brownish yellow wings, front wings with the triangle three-celled, subtriangular space three-celled and at least three posttriangular rows; triangle on the hind wing two-celled.

6. The present specimens from Tepic closely resemble the "*tenuicincta*" and "*tenera*" of the United States. The

males have the brown spot on all the wings as described in the third paragraph. The variations in neuration are shown in the following tables:—

### FRONT WINGS.

Number of individuals examined.	TRIANGLE.			SUBTRIANGULAR SPACE.			
	2-celled both wings	3-celled both wings	2-celled one wing 3-celled other wing	3-celled both wings	2-celled both wings	3-celled one wing 2-celled other wing	2-celled one wing 1-celled other wing
21 ♂	18	1	2	7	5	8	1
25 ♀	17	1	7	6	6	8	5
46	35	2	9	13	11	16	6

### HIND WINGS.

Number of individuals examined.	TRIANGLE.				
	3-celled both wings	2-celled both wings	1-celled both wings	3-celled one wing 2-celled other wing	2-celled one wing 1-celled other wing
20 ♂ <sup>1</sup>	0	14	1	3	2
25 ♀	1	21	0	2	1
45	1	35	1	5	3

<sup>1</sup> Not 21 as in the first table, as the hind wings of one male were destroyed.

These tables seem to justify the conclusion that *the number of cells in these areas are not characters of specific value.* Moreover, the data on which these tables are based permit the following statement: *Variations, symmetrical or asymmetrical, in the number of cells of any one of these three areas, viz., the triangle of the front wings, the triangle of*

*the hind wings, and the subtriangular space of the front wings, occur independently and entirely out of correlation with variations in the number of cells of either of the other two.* (Both italicized statements apply to *Perithemis* only.)

Lastly, these individuals from Tepic are larger than those from the eastern United States—abdomen, ♂ 13–15.5 mm., ♀ 15 mm.; hind wing, ♂ 18–21 mm., ♀ 20 mm.

#### 41. *Lepthemis vesiculosa* Fabricius.

*Libellula vesiculosa* FABR., Syst. Ent., 1775, p. 421.

*Lepthemis vesiculosa* KIRBY, Cat. Odon., 1890, p. 39.

1 ♂		Mazatlan, Sept., 1894, Eisen and Vaslit.
3 ♂	1 ♀	“ Oct., 1894, “ “ “
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4 ♂	1 ♀	

#### 42. *Lepthemis verbenata* Hagen.

*Lepthemis verbenata* HAGEN, Syn. Neur. N. Am., 1861, p. 162.

1 ♂, no locality or date, probably Tepic, Eisen and Vaslit.

Hagen<sup>1</sup> followed by Kirby<sup>2</sup> has referred *verbenata* to *attala* Selys, with *mithra* Selys and *annulata* (pars) Ramb. as other synonyms. I think *verbenata* is specifically distinct on the following grounds:—

1. Selys' description of *attala*<sup>3</sup> reads “abdomine crasulo brevi” an expression not applying to *verbenata* Hagen, the type of which I have studied in the Museum of Comparative Zoology.

2. The same Museum contains a male and a female with pin-labels in de Selys' handwriting, “*Libellula isis* De Selys Bresil.” They were, therefore, probably regarded

<sup>1</sup> Proc. Bost. Soc. Nat. Hist., Vol. XVIII, 1875, p. 74.

<sup>2</sup> Cat. Odon., 1890, p. 40.

<sup>3</sup> Sagra Hist. Cuba Ins., p. 445.



by him as distinct from his *attala*, but they are the same species as *verbenata*—and were so placed by Dr. Hagen.

3. Specimens whose abdomens do correspond with “*crassulo brevi*” were left by Dr. Hagen under distinct specific labels, “*M. mithra* Selys” and “*M. annulosa* Selys” in a separate drawer in the same Museum.

4. Neither the collections there nor in Philadelphia contain any transitional forms between the thick-abdomined *annulosa-attala-mithra* group and the slender-abdomined *verbenata*.

I have not been able to find any other constant character separating these. The nearest approach thereto is in the proportions of the terminal abdominal appendages of the male. In the majority of males of *verbenata* the inferior appendage is one-third shorter than the superiors and does not reach as far back as the inferior denticles thereof. In the *attala-mithra-annulosa* group, the inferior appendage is very little shorter—one-sixth to one-eighth—than the superiors and reaches farther back than the last denticle of the latter. A male of *verbenata* from Cuba by Poey<sup>1</sup> closely approaches the proportions of the other group, however.

That *attala*, *mithra* and *annulosa* are species distinct from each other appears improbable. *Annulosa* Selys<sup>2</sup> has the dark brown spot at the base of the hind wings reaching to the triangle, in *attala* and *mithra* it does not extend so far, *mithra* being distinguished by its narrower (9.5 mm.) hind wings from *attala*<sup>3</sup> (11 mm.) In no individual of *verbenata* does the brown at the base of the hind wings reach farther out than the first antenodal.

The distribution of the slender bodied *verbenata* is Cuba (Poey), Hayti (Uhler), Jamaica (Bath by Mrs. Swainson, Kingston by C. W. Johnson and W. J. Fox), Mazatlan, Mexico, Oct., 1873 (Crotch), Porto Cabello, Venezuela (Appun), Surinam (Thorey), Brazil (Selys); of the

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<sup>1</sup> In the Mus. Comp. Zool.

<sup>2</sup> l. c., p. 445.

<sup>3</sup> Selys l. c., pp. 445, 446.

thick-bodied *annulosa*, etc., is Cuba (Gundlach, Poey), Rio Janeiro (Winthem) and Paramaribo (Thorey), Brazil.

These studies on *verbenata* caused me to study the characters separating the "genera" *Lepthemis* and *Mesothemis*, and I have been able to find no constant character other than the shape of the abdomen. *Verbenata* is from this point of view a *Lepthemis*, *attala-mithra-annulosa*, a *Mesothemis*. A surprise was to find, from an examination of the type, that *credula* Hagen<sup>1</sup> is also a *Mesothemis*.

## II. SUPPLEMENTARY NOTES ON THE ODONATA OF BAJA CALIFORNIA.

### 16.<sup>2</sup> *Æschna cornigera* Brauer.

*Æschna cornigera* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 507, Pl. XV, figs. 24, 31, 32.

I have studied Brauer's male type in the K. K. Hofmuseum at Vienna and found the following differences in neurulation from my description:—

Front wings: 15 (right) 14 (left) antecubitals, 11 (right) 9 (left) postcubitals, 4 (right) 3 (left) [sub] median cross-veins. Hind wings: 11 (right) 10 (left) antecubitals, 13 (right) 12 (left) postcubitals.

*Dimensions:* Total length 58 mm.; abdomen 44 mm.; superior appendages 4.75 mm.; front wing 41 mm.; hind wing 40 mm.; pterostigma 2.5 mm.

I do not think that these measurements indicate specific difference.

### 24. *Tramea longicauda* Brauer (?) var.

*Tramea longicauda* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 514, Pl. XVII, figs. 88, 89.

I have studied Brauer's male type of this also at Vienna. It differs from my description as follows:—

*Male.* Superior appendages 4.5 mm. long (8+9+10=5 mm., 9+10=3 mm.) Inferior appendage not quite half as long as the superiors, but

<sup>1</sup> Syn. Neur. N. Am., p. 184.

<sup>2</sup> The numbers refer to the species mentioned in a former report. Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94.

reaching beyond their denticles. Penis partly protruded, the genitalia therefore not readily examined, but apparently similar. Color of the veins at base of the wings darker, perhaps faded. Veins in the basal band of the hind wings brown, not yellow; the pale tract along the anal margin of these wings not obscurely yellowish, but uncolored and narrower (three cells at most). Front wings with eleven antecubitals, 11 (right) 10 (left) postcubitals.

*Dimensions:* Pterostigma of front wings  $2\frac{3}{4}$  mm., of hind wings  $2\frac{1}{4}$  mm. Total length 49 mm.; abdomen 32 mm.; hind wing 40 mm.

I still retain this provisional name for the two males from Baja California.

### 29. *Paltothemis lineatipes* Karsch.

*Dythemis russata* (HAGEN MS.) CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 526, Pl. XVI, figs. 46-49.

*Paltothemis lineatipes* KARSCH, Berl. Ent. Zeit., Bd. XXXIII, 1889, p. 363; CALVERT, Proc. Bost. Soc. Nat. Hist., Vol. XXVIII, 1898, p. 312, Pl. I, figs. 1, 8, 9.

I have studied Dr. Karsch's type, from Brazil, in the Museum für Naturkunde, Berlin. I must plead guilty to having overlooked his description when writing on this species. The statement "der vierte Ring mit einer Querkannte versehen" is erroneous, as such does not exist in the type, nor in mine. The type has the frons red, not "gelb." I have seen three males and one female of this species from Merida in the Vienna Museum, and in the Museum of Comparative Zoology at Cambridge are two males and one female from Arizona and one male from Texas.

### 39. *Cannacria furcata* Hagen.

*Cannacria furcata* CALVERT, Proc. Cal. Acad. Sci., 2d Ser., Vol. IV, 1893-94, p. 548, Pl. XVII, figs. 110-113.

I gave as a character distinguishing *furcata* from *Batesii* Kirby that the superior appendages of the male *Batesii* had no inferior tooth, basing this statement on Mr. Kirby's figure. An examination of the types in the British Museum showed this to be false and that such a tooth does exist. The black dorsal band on 3 or 4-9, however, distinguishes *Batesii* from *furcata*, and causes it to resemble *gravidula* Calv.

Structurally, *Batesii* is intermediate between *furcata* and *gravidia*, as the apex of the superior appendages of the male is neither so tapering as in the former nor so rounded as in the latter, while the anterior lamina is more prominent than in *furcata*, less prominent than in *gravidia*. An examination of specimens in the British Museum marked *Cannacria Smithii* Kirby<sup>1</sup> failed to show any specific differences from *furcata*.

### III. NOTES ON SOME OF THE INTERNAL ORGANS.

I have dissected a number of individuals of various species both from Baja California and from Tepic. Attention was chiefly paid to the thoracic and abdominal ganglia and to the gizzard.

The *prothoracic* pair of ganglia is always distinct from the *mesothoracic*, but the interval between this latter and the *metathoracic* pair varies, although it is rarely as great as that between pro- and mesothoracic or as long as are either the meso- or metathoracic ganglia themselves; such an infrequent case is that of *Heterina americana*. In *Lestes tenuatus*, *Archilestes grandis*, *Mecistogaster ornatus*, *Argia agrioides*, *Erythrargion saluum*, *Herpetogomphus elaps*, *Diplax corrupta* and *Dythemis sterilis*, more or less of an interval was apparent separating the mesothoracic from the metathoracic pair. In *Orthemis ferruginea* and *Mesothemis simplicicollis* var. *collocata* there was no such appreciable interval. These results are not important, however, as it is very difficult to define exactly just how great the interval may be, or to avoid all tension on the parts in dissection.

More important is the variation in the position of the first pair of abdominal ganglia. The usual statement has been that it is located in the first abdominal segment of all Odonata. In *Heterina americana*, *Lestes tenuatus*, *Archilestes grandis*, *Mecistogaster ornatus*, *Argia agrioides*, *Erythrargion saluum*, *Ischnura Ramburii* var. *credula*, all Zygoptera, the first abdominal pair of ganglia lie in the hind part

<sup>1</sup> Ann. Mag. Nat. Hist., 6th Ser., Vol. XIV, 1894, p. 266.

of the metathorax, distinctly removed from the abdominal segment, while in *Anax junius*, *Herpetogomphus elaps*, *Pantala hymenæa*, *Tramea onusta*, *Pseudoleon superbus*, *Orthemis ferruginea*, *Dythemis sterilis*, *Trithemis basifusca*, *Micrathyria Hageni*, *Diplax corrupta* and *Mesothemis simplicicollis* var. *collocata* (all Anisoptera) the first pair is located in segment 1 or at its articulation with the second abdominal segment. How this difference (which I do not find noticed in the literature) is brought about is yet to be investigated; all young larvæ hitherto studied, whether of the Zygoptera or the Anisoptera, have eight abdominal ganglia, located in the first eight abdominal segments. In all the species above mentioned the other six abdominal ganglia of the imago (the imagos have but seven abdominal ganglia) are located as usual in segments 3, 4, 5, 6, 7 and 8.

The study of the gizzard was prompted by the recent publication of Dr. F. Ris' valuable and interesting paper on this neglected organ.<sup>1</sup>

The gizzard, as in other insects, is at the posterior termination of the foregut, where it projects into an invagination of the front end of the midgut, thus forming a valve. It has been stated by previous authors, including the writer and Dr. Ris,<sup>2</sup> that in all the Odonate groups the junction of fore- and midgut lies in the second abdominal segment. Much to my surprise, therefore, I found its position, and, therefore, that of the gizzard, to be very variable, as the following shows:—

In *Heterina americana* the gizzard was found to lie in the fourth, fifth or sixth abdominal segments in different individuals; in *Lestes tenuatus* in the sixth; in *Archilestes grandis* in the fourth or the sixth; in *Mecistogaster ornatus* opposite the articulation of the sixth and seventh; in *Argia agrioides*, *A. pulla*, *Erythrargrion salvum*, and *Ischnura Ramburii* var. *credula* in the sixth; in *Anax junius* in the

<sup>1</sup> Zoologische Jahrbücher, Bd. IX, 1896, pp. 596-624. Summary in Ent. News, February, 1897, p. 39.

<sup>2</sup> l c., p. 606.

second; in *Pantala hymenaea*, *Pseudoleon superbus*, *Micrathyria Hageni* and *Dythemis sterilis* in the third; in *Orthemis ferruginea*, *Trithemis basifusca*, *Tramea onusta*, and *Mesothemis simplicicollis* var. *collocata* in the fourth.

In the preparation of the chitinous linings of the gizzards described below, care was taken to open them along the mid-dorsal line, an essential precaution in the case of the Anisoptera though not so necessary in the Zygoptera, where the small calibre of the alimentary canal renders this quite difficult.



FIG. 1.\*—Chitinous lining of the gizzard of *Heterina americana* Fabr., male, from Tepic.

(Camera lucida drawing, Reichart oc. 4, Leitz obj. 3, draw-tube out).

\* The following explanation applies to the four text figures. These figures show the chitinous teeth with which the gizzards are armed, while the lines represent the folds into which the chitin is thrown, following the foldings of the other coats of the foregut. In their natural position the teeth, with one exception noted in the text for *Argia agrioides*, point backwards.

Although my preparations of the gizzard of *Heterina americana* are not entirely satisfactory, I believe that they are sufficiently so to justify the statement that the armature of the chitinous coat here consists of a girdle of four folds, each covered with a great number of very minute teeth (.002 mm. long) for a length of about .52 mm. and a width of .05 mm. There are no large teeth and no intermediate tooth-bearing folds.

The armature of the gizzard of *Archilestes grandis* agrees with that described and figured by Dr. Ris<sup>1</sup> for *Lestes virens*

<sup>1</sup> I. c., p. 615.

—eight fields covered with minute teeth .005 mm. long, four of which are wider than the other four and alternate with them. The wider fields have a width of .13–.15 mm. and a length of .45 mm., the narrow fields are .08–.1 mm. wide and .4 mm. long. A wide field occasionally bears also a single large tooth .03–.04 mm. long.

*Lestes tenuatus* appears to be similar to *Lestes virens*.

The gizzard of *Mecistogaster ornatus* is lined with such extremely small teeth that their examination is a matter of some difficulty. I believe that I can distinguish sixteen fields whose width is alternately greater and less, although the difference between a wide and a narrow field is not as great as in *Archilestes*, and which are separated from each other by intervals narrower than the fields themselves. The teeth are smaller than those of *Heterina americana*, and I can find no larger teeth.

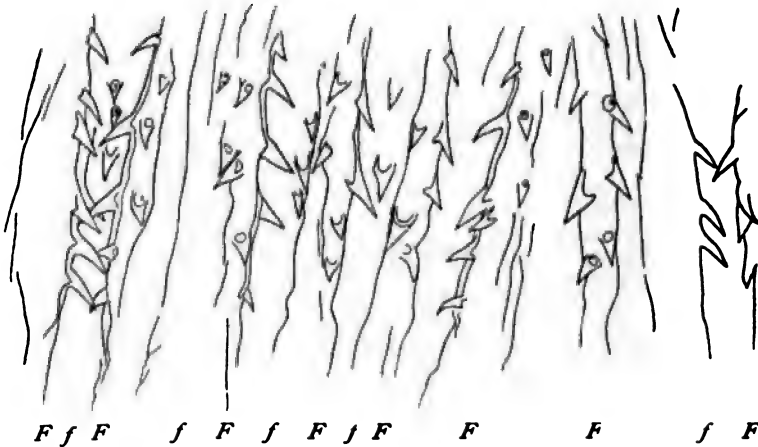


FIG. 2.—Chitinous lining of the gizzard of *Argia pulla* Selys, male, from Tepic.  
(Camera lucida drawing, Reichert oc. 2, Leitz obj. 7, draw-tube in).

In *Argia pulla* there are eight folds (*F*) not very greatly chitinized, .15–.18 mm. long, each bearing from six to nine strong, straight or slightly curved, sharp-pointed teeth .015–.02 mm. long. With these eight folds there usually, but not always, alternate shorter and narrower folds (*f*), which bear from one to three teeth of the same shape and size.

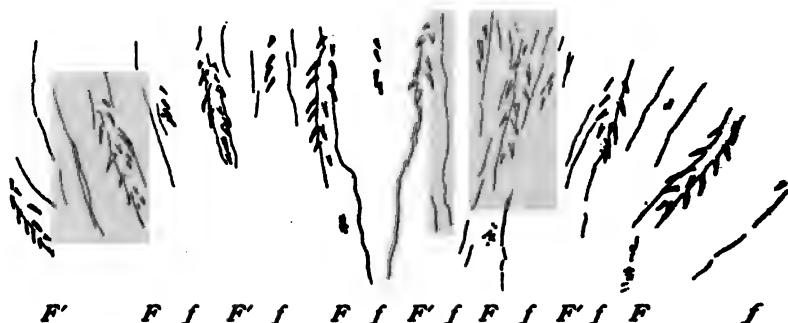


FIG. 3.—Chitinous lining of the gizzard of *Argis agrioides* Calvert, female, from Baja California.  
(Camera lucida drawing, Reichert oc. 4, Leitz obj. 3, draw-tube out).

In *Argis agrioides* the arrangement is similar, but the eight large folds themselves show an alternation, four of them (*F*) being .26-.3 mm. long and bearing twelve to twenty-four curved, sharp-pointed teeth .02-.03 mm. long, while .1 mm. behind the posterior end of each of these four folds is a patch<sup>1</sup> .05 mm. long of ten to twelve small teeth .005 mm. long, which are directed *anteriorly*. The other four (*F'*) of the eight large folds are .15-.2 mm. long, and bear ten to seventeen teeth, of the same shape and size as on the preceding four folds; these teeth are consequently closer together, but there are no patches of small teeth following. The eight small folds (*f*) bear from one to nine teeth like those of the eight large folds.

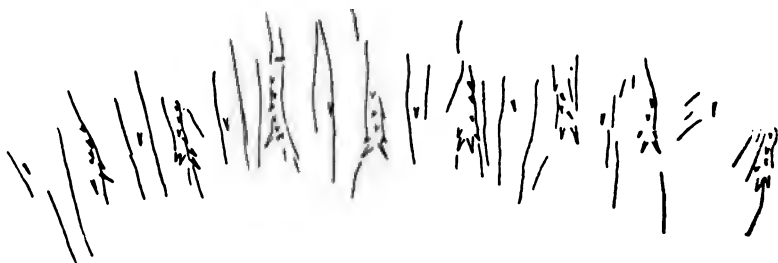


FIG. 4.—Chitinous lining of the gizzard of *Erythrargrion salvum* Hagen, male, from Baja California.  
(Camera lucida drawing, Reichert oc. 4, Leitz obj. 3, draw-tube out).

In *Erythrargrion salvum* there are eight larger folds, .13 mm. long, bearing six to nine straight, sharp teeth .007-.026 mm. long, so arranged that on each fold they increase in

<sup>1</sup> Only three of these patches which follow folds (*F*) are shown in fig. 3; the fourth, or that nearest the left hand, was accidentally omitted by the engraver.



length from before backwards. Alternating with these eight larger folds are usually one or two teeth .018–.025 mm. long, these teeth thus corresponding to the eight small folds of *Argia*.

In *Ischnura Ramburii* var. *credula*, the eight large folds are .26 mm. long and bear fourteen to eighteen teeth .015–.02 mm. long. The eight small folds are represented by shorter patches covered with minute granulations but without teeth.

For *Anax junius* and *Herpetogomphus elaps* my results agree completely with Dr. Ris' for the subfamilies *Æschininae* and *Gomphinae*. The chitinous coat of the gizzard is covered with minute granulations, without differentiation into fields, which likewise extend throughout a very considerable part of the foregut.

A similar granulation exists in the gizzard of the *Libellulinae*, but with this difference, that it is denser immediately surrounding the four "tolerably thin, translucent, chitinous platelets with irregular contours" which take the place of the teeth of the larval gizzard in this subfamily. These chitinous platelets are visible to the naked eye in the preparations, being often 1.5 mm. in length or longer. As Dr. Ris pointed out, they are bilaterally symmetrical in their arrangement and their shape. I have found differences to exist in their relative lengths and widths which I here place on record, although it would be rash to assume that these particulars represent specific or generic characters until a larger number of individuals have been studied.

As to length, all four platelets were found to be approximately equal in *Pantala hymenaea* and *Pseudoleon superbus*, the ventral pair somewhat longer than the dorsal pair in *Tramea onusta*, *Dythemis sterilis* and *Micrathyria Hageni*, shorter than the dorsal pair in *Orthemis ferruginea* and *Diplax corrupta*. The ventral pair were found distinctly broader posteriorly than anteriorly in *Pantala hymenaea*, *Pseudoleon superbus* and *Diplax corrupta*, tapering and pointed posteriorly in *Tramea onusta*, *Orthemis ferruginea*, *Dythemis sterilis* and *Micrathyria Hageni*.

The gizzard of many more Odonata must be studied before it will be safe to draw phylogenetic conclusions from its armature, and for this reason I prefer not to offer any suggestions on this subject based on the present results. I may remark that Dr. Ris has said that *Lestes* appears to him to be "farther removed from the typical Agrioninæ than even the *Pseudostigma* group [to which *Mecistogaster* belongs], perhaps even than the majority of the Calopteryginæ." To me it seemed that the principal character of *Lestes*, viz., that the median and subnodal sectors part from the principal sector much nearer the arcus than the nodus, was a strong reason for regarding this Légion as nearest to the Calopteryginæ. Nevertheless, one of the soundest results which Dr. Ris has obtained from his studies is, I think, the evidence for the close relationship between the Cordulegasterinæ and the Libellulidæ, and of this evidence the gizzard furnishes an important part.

As to the function of the gizzard in those species in which it is provided with large teeth, I have attempted to form an idea by comparing the size of the fragments in the alimentary canal posterior to the gizzard with fragments taken from in front of this organ. Such an examination made under the microscope in the case of *Argia agrioides* has failed to show any appreciable difference in the size of the fragments composing the two samples. It may be said, however, that the particles taken from behind the gizzard were less compactly massed than those from in front, and the teeth of the gizzard may have had a part in producing this result. Further, if the teeth of the gizzard really do aid in comminuting the food, one would not be surprised to find that the mandibles and maxillæ of species with toothed gizzards were less tuberculate and ridged than in species where the gizzard is not toothed. A comparison of the mouth-parts of *Argia agrioides* and *Anax junius*, as representatives of these two conditions of gizzard, respectively, does not seem to bear out this expectation, as the only greater complexity possessed by the latter appears to be two long spines on the maxillæ, wanting in the former.

## INDEX TO GENERA AND SPECIES

OF

## MEXICAN ODONATA.

New species in full face, synonyms in *italics*.

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## EXPLANATION OF PLATE XXV.

All the figures were drawn with the aid of a camera lucida, with the optical combinations oc. 2, obj. 3, Leitz, or oc. 4, obj. AA, Zeiss.

- Fig. 1. Vulvar lamina of *Herpetogomphus viperinus* SELYS, female.  
 Fig. 2. Vulvar lamina of *Herpetogomphus elaps* SELYS, female.  
 Fig. 3. Apex of the abdomen of *Lestes tenuatus* RAMBUR, male. The right superior appendage is represented as broken off near the base to show the right inferior appendage (*inf. app.*) below it; *inf. app.* is homologous to the part marked *app. lat.* in fig. 5; *app. d.*, appendix dorsalis of Heymons, or tergum of the eleventh segment, which is homologous with the inferior appendage in figs. 5, 7 and 13.  
 Fig. 4. Left side of the apex of the abdomen of *Argia pulla* SELYS, male.  
 Fig. 5. The same of *Herpetogomphus viperinus* SELYS, male; see the explanation of figure 3. *App. lat.*, appendix lateralis (sternite of eleventh segment) of Heymons.  
 Fig. 6. Left side of apex of abdomen of *Argia Harknessi*, sp. nov., male.  
 Fig. 7. Right side of apex of abdomen of *Macrothemis inacuta* CALVERT, male.  
 Fig. 8. Left side of apex of abdomen of *Argia extranea* HAGEN, male.  
 Fig. 9. Left side of the genitalia of the second abdominal segment of *Anatya normalis*, sp. nov., male, the insect being held upside down, as also in figs. 10 and 12.  
 Fig. 10. The same of *Macrothemis inacuta* CALVERT, male.  
 Fig. 11. Left side of apex of abdomen of *Argia fissa* SELYS, male.  
 Fig. 12. Left side of the genitalia of the second abdominal segment of *Brechmorhoga postlobata* CALVERT, male.  
 Fig. 13. Right side of apex of abdomen of *Anatya normalis* sp. nov., male.

## SIGNIFICANCE OF REFERENCE LETTERS.

In figs. 9, 10 and 12—

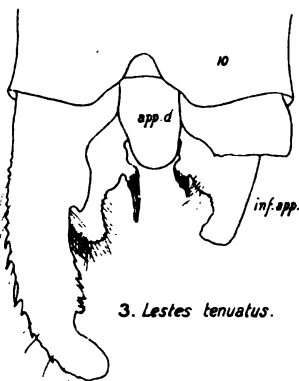
- al.* anterior lamina.
- gl.* genital lobe.
- h.* hamule.
- ih.* internal branch of hamule.
- p.* penis.
- sh.* external branch of hamule.
- t.* posterior tubercle of genital lobe.
- vp.* vesicle of the penis.



1. *Herpetogomphus viperinus*.



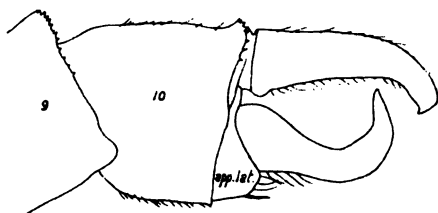
2. *Herpetogomphus elaps*.



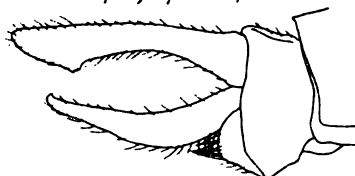
3. *Lestes tenuatus*.



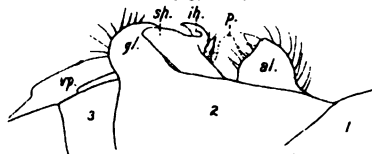
4. *Argia pulla*.



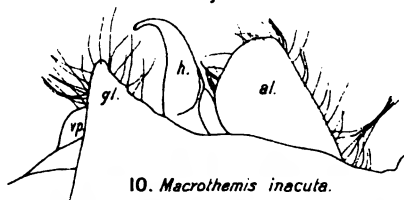
5. *Herpetogomphus viperinus*.



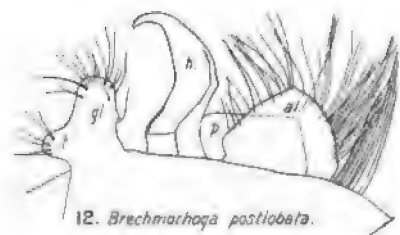
7. *Macrothemis inacuta*.



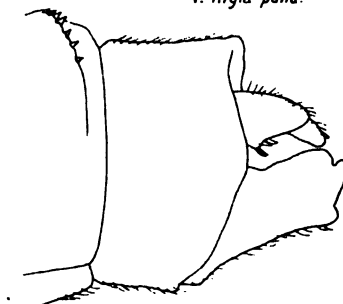
9. *Anatya normalis*.



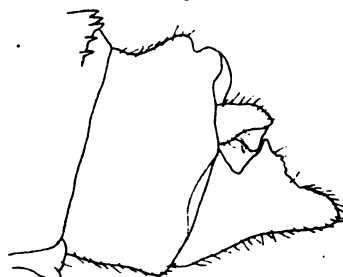
10. *Macrothemis inacuta*.



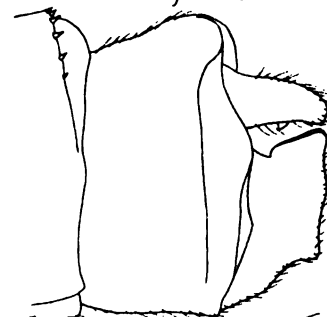
12. *Brechmarchoga postlobata*.



6. *Argia Harknessi*.



8. *Argia extranea*.



11. *Argia fissa*.



13. *Anatya normalis*.



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## ERRATA.

- Page 11, 4th line from bottom, for "on" read "in."
- " 17, 8th line from bottom, for "juxtaposition" read "contradistinction."
- " 30, 10th line, for "through" read "from."
- " 39, 2nd line from bottom, for "0.6" read "0.6 per cent."
- " 41, 7th line from bottom, for "protozoa" read "protozoan."
- " 53, 24th line, for "converts" read "covers."
- " 55, 14th line from bottom, for "Heneguy" read "Henneguy."
- " 56, 1st line, after "la Valette" insert "St. George."
- " 56, 19th line, after "used" insert "an."
- " 63, for "mm." after measurements read " $\mu$ ."
- " 75, 14th line, for "*Tricha*" read "*Taricha*."
- " 80, 2nd line from bottom, for "*Lepidosteous*" read "*Lepidosteus*."
- " 80, last line, for "*spirifer*" read "*spiniifer*."
- " 89, last line, for "fig. 2" read "fig. 3."
- " 94, 22d line, for "urodelos" read "urodelous."
- " 99, 22d line, for "*T. cristalus*" read "*T. cristatus*."
- " 100, 6th line from bottom, for "*Amblystonea*" read "*Amblystoma*."
- " 101, 6th line, for "object" read "objects."
- " 104, 17th line from bottom, for "*Amblystomea*" read "*Amblystoma*."
- " 106, 8th line, for "*lugubris*" read "*tenebrosus*."
- " 106, 17th line, for "Cadis" read "Caddis."
- " 253, 2nd line from bottom, for "*helveola*" read "*helvola*."
- " 256, 9th line from bottom, for "p. 114" read "p. 126."
- " 258, 20th line, for "*guatemalense*" read "*guatemalensis*."
- " 292, for "*Rhyncolophus*" read "*Rhyncholophus*."



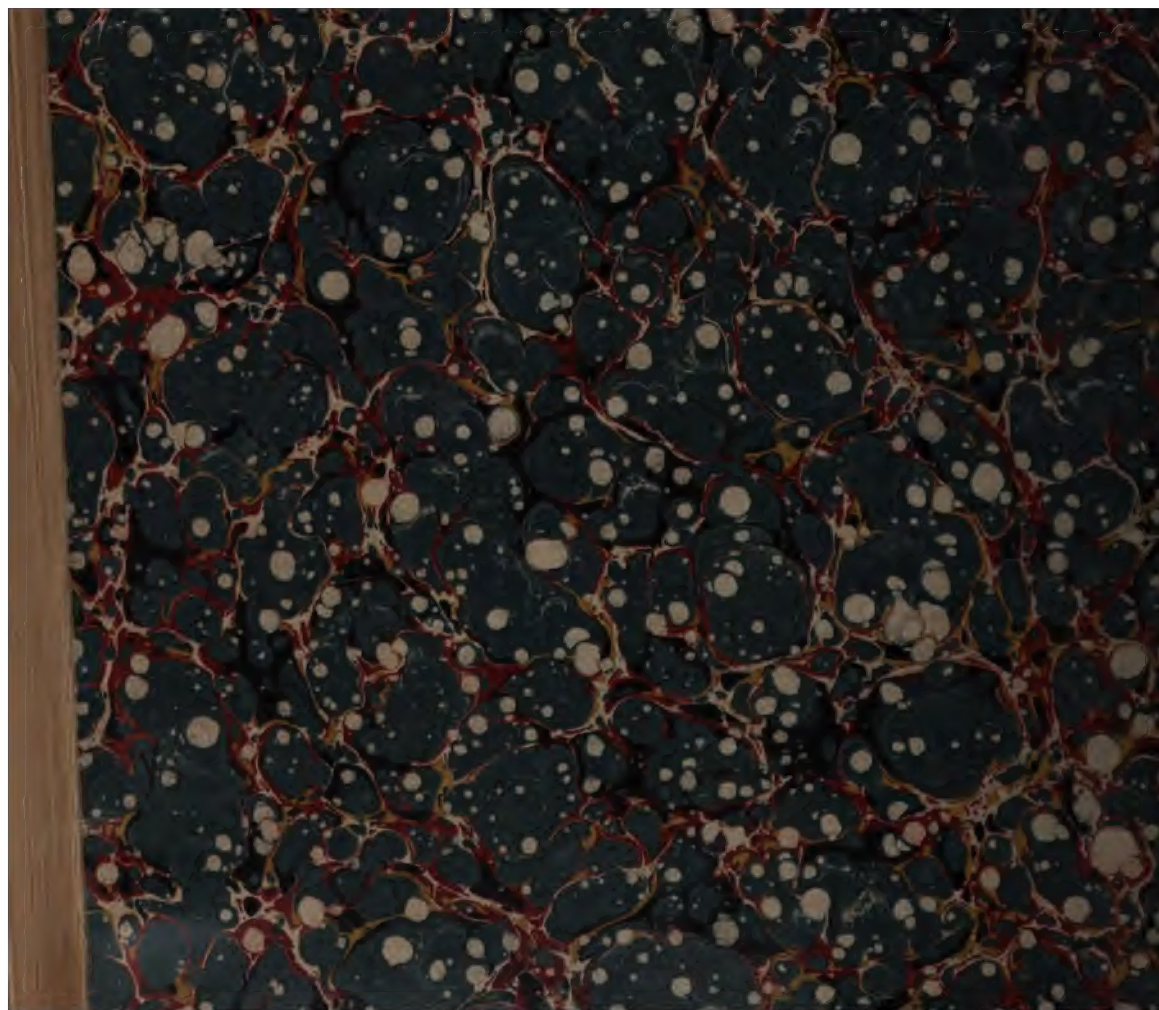


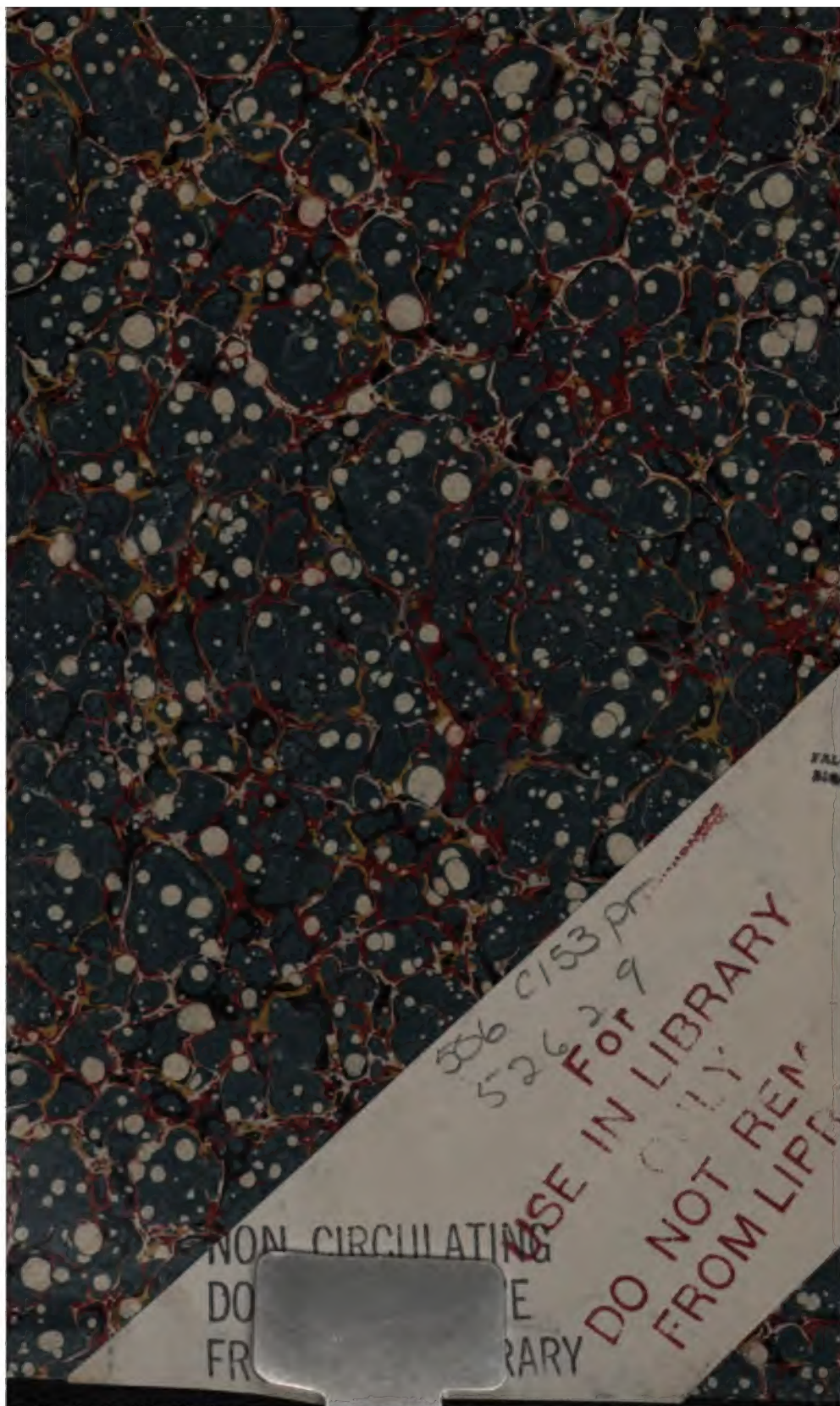












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